

**IN UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD**

SAMSUNG ELECTRONICS CO., LTD. AND
SAMSUNG ELECTRONICS AMERICA, INC.

Petitioners,

v.

MAXELL, LTD.,
Patent Owner

Case: IPR2025-01312

U.S. Patent No. 7,952,645

DECLARATION OF MATTHEW TURK, Ph.D.

I hereby 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 the knowledge that willful false statements and the like so made are punishable by fine and/or imprisonment under Section 1001 of Title 18 of the United States Code, and such willful false statements may jeopardize the validity of the patent which is under review in this proceeding.

Dated: May 12, 2026


Matthew A. Turk, Ph.D.

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I. INTRODUCTION

1. My name is Matthew Turk, and I have prepared this declaration at the request of Maxell, Ltd. (“Maxell”). This declaration provides my opinions with respect to various aspects of the Petition filed by Petitioner relating to U.S. Patent No. 7,952,645 (“the ’645 Patent”).

2. Depending on any new information learned including positions taken by Petitioner or Petitioner’s expert, I reserve the rights to supplement my opinions included herein.

3. I am being compensated at my usual consulting rate of \$625 per hour for my time reviewing materials and preparing this declaration. My opinions expressed here are my own. My compensation is not dependent on the outcome of this case, and I have no other financial interest in this matter or the parties thereto.

4. In forming my opinions, I have relied on my knowledge and experience, as well as the documents and information referenced in this report.

II. BACKGROUND AND QUALIFICATIONS

5. A detailed description of my professional qualifications, including a listing of my specialties/expertise and professional activities, is contained in my curriculum vitae, a copy of which is attached as Appendix A. In what follows, I provide a short summary of my professional qualifications.

6. I am an Emeritus Professor in the Department of Computer Science at the University of California, Santa Barbara (UCSB) and the former President of the Toyota Technological Institute at Chicago (TTIC). I have worked and studied in the field of computer vision and image processing since 1984, as well as in related areas of pattern recognition, machine learning, augmented and virtual reality, and human-computer interaction. The field of computer vision is concerned with determining how computers can extract, analyze and understand information from images and video, and my work has been directed to a wide range of applications, including improving camera image and video outputs (a.k.a. computational photography), estimating 3D scene structure for autonomous vehicles or augmented reality interaction, recognizing objects such as faces, and modeling human movements and gestures for gaming, surveillance, and other interactive systems.

7. I received my Bachelor of Science degree in Electrical Engineering from Virginia Tech (VPI&SU) in Blacksburg, Virginia in 1982, where my senior honors thesis was on image processing, and my Master of Science degree in Electrical and Computer Engineering from Carnegie Mellon University in 1984, where my research focused on robot fine motion planning. I received my doctorate degree in Media Arts and Sciences from the Massachusetts Institute of Technology (MIT) in 1991. My doctoral research was in the area of computer vision, specifically concerning automatic face recognition, introducing a now widely recognized

approach to representing and recognizing human faces in images called Eigenfaces. This research helped lead to practical automated face recognition systems that are used in today's consumer applications and security and surveillance systems. My work on Eigenfaces received several awards, including an IEEE Computer Society Outstanding Paper award at the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) in 1991 and a "Most Influential Paper of the Decade" award from the International Association for Pattern Recognition (IAPR) Workshop on Machine Vision Applications (MVA 2000).

8. My industry experience includes working for Martin Marietta Denver Aerospace from 1984 to 1987, where I worked primarily on computer vision for autonomous vehicle navigation. In 1992, I was a visiting researcher at LIFIA/ENSIMAG in Grenoble, France and from 1993 to 1994, I worked for Teleos Research in Palo Alto, CA; in both of those positions, I worked on computer vision methods for recognizing human faces, gestures, and activity. From 1994 to 2000, I was a researcher for Microsoft Research, where I founded the Vision Technology Research Group and conducted research in vision-based human computer interaction and related areas.

9. In 2000, I joined the faculty of the University of California, Santa Barbara, as an Associate Professor. In 2005, I was promoted to Full Professor and served as the Chair of the Media Arts and Technology Graduate Program from 2005

to 2010. In 2017, I was appointed as Chair of the Department of Computer Science. At UCSB, I taught graduate and undergraduate courses related to computer vision, mobile imaging, human computer interaction, computer graphics, machine learning, and several other topics. My graduate courses covered the fundamentals of imaging systems related to mobile devices, including the capture, storage, display, retrieval, and processing of images, as well as the nature of light, color, optics, human vision, and multispectral imaging, sensors, cameras, and illumination.

10. In 2003, I co-founded the Four Eyes Lab at UCSB, where the research focus is on the “four I’s” of Imaging, Interaction, and Innovative Interfaces. The Four Eyes Lab researches a variety of topics, including computer vision, pattern recognition, virtual and augmented reality, and human-computer interaction technologies. I worked on and supervised many research projects in these areas.

11. In 2014, I co-founded a startup company, Caugnate, to commercialize computer vision and augmented reality technology for remote collaboration. Caugnate was acquired by PTC Inc. in 2016 and subsequently formed the core of the Vuforia Chalk augmented reality product.

12. In 2019, I became President of the Toyota Technological Institute at Chicago, an independent graduate academic institution, where the research and education focus of the faculty and Ph.D. students is on computer science theory,

machine learning, artificial intelligence, and related areas such as computer vision, speech and language processing, robotics, and computational biology.

13. I have received several other awards at professional conferences and workshops for my work in computer vision, image processing, and augmented reality, including several best paper awards and winning the ACM Multimedia Open Source Competition in 2015. My co-authors and I presented the paper “Location-based augmented reality on mobile phones,” at the 2010 IEEE International Workshop on Mobile Vision and received the Best Paper Award. At the 2012 IEEE International Symposium on Mixed and Augmented Reality (ISMAR), my co-authors and I received the Best Paper Award for “Live tracking and mapping from both general and rotation-only camera motion.” At the 2015 IEEE International Symposium on Mixed and Augmented Reality (ISMAR), my co-authors and I received the Best Short Paper Award for “Efficient Computation of Absolute Pose or Gravity-Aware Augmented Reality.” My co-authors and I also received a Best Paper Honorable Mention for our paper, “Interpreting 2D Gesture Annotations in 3D Augmented Reality,” at the 2016 IEEE Symposium on 3D User Interfaces (3DUI).

14. As a result of my work and research, I am a named inventor of U.S. Patent Number 6,674,877 entitled “System and Method for Visually Tracking Occluded Objects in Real-time,” U.S. Patent Number 5,164,992 entitled “Face

Recognition System,” and U.S. Patent Number 9,495,761 entitled “Environment mapping with automatic motion model selection.”

15. I was a founding member of the Advisory Board for the International Conference on Multimodal Interfaces (ICMI), which provides a venue for disseminating recent advances in multimodal interaction research, systems, and methods, which includes combining visual modalities with audio, haptic, or other modalities. I served as the Chair of the ICMI Advisory Board from 2006 to 2009. I was also a founding member of the Advisory Board for the IEEE International Conference on Automatic Face and Gesture Recognition and served as the General Chair for the conference in 2011. I have been a primary organizer of several top research conferences, including serving as General Chair for the 2014 IEEE Conference on Computer Vision and Pattern Recognition, the primary annual conference in the field of computer vision, with over 2000 attendees, Program Chair for the 2017 IEEE Winter Conference on Applications of Computer Vision, and General Chair of the 2019 International Conference on Multimodal Interfaces (ICMI).

16. I am currently an Associate Editor of the ACM Transactions on Intelligent and Interactive Systems and the International Journal of Computer Vision and Signal Processing and was formerly an Associate Editor of Image and Vision

Computing. I have also served as a guest editor of several other journals related to computer vision, machine learning, and interactive systems.

17. A listing of my publications is included in my curriculum vitae attached to this declaration. I am a named author on over 250 refereed publications dated back to 1985. My research publications have received over 45,000 citations.

18. In 2020, I was elected a Fellow of the Association for Computing Machinery (ACM), the preeminent professional society in the field of computer science, for “contributions to face recognition, computer vision, and multimodal interaction.” In 2013, I was elected as a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), an award conferred by the Board of Directors of the IEEE upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. In 2014, I was elected as a Fellow of the International Association for Pattern Recognition (IAPR). In 2022, I was named as a Fellow of the Asia-Pacific Artificial Intelligence Association. In 2023, I was named as a Fellow of the International Artificial Intelligence Industry Alliance. I am also the recipient of the 2011-2012 Fulbright-Nokia Distinguished Chair in Information and Communications Technologies. I have given many keynote presentations at top conferences and workshops in my fields.

III. UNDERSTANDING OF LEGAL STANDARDS

19. I am not a lawyer and am not offering any opinions regarding legal matters. However, I have been informed about legal standards of patent law, which I have used in developing my opinions expressed herein.

20. I understand that a patent may include two types of claims: independent claims and dependent claims. An independent claim stands alone and includes only the limitations it recites. A dependent claim can depend from an independent claim or another dependent claim and includes all the limitations that it recites in addition to all of the limitations recited in the claim or claims from which it depends.

A. Obviousness

21. I understand that a patent claim can be invalid under 35 U.S.C. § 103 if the claimed subject matter would have been “obvious” to a Person of Ordinary Skill in the Art (a “POSITA”) as of the priority date of the patent based upon one or more prior art references. I understand that an obviousness analysis should consider each of the following so-called “*Graham* factors”: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the pertinent art; and (4) secondary considerations, if any (such as unexpected results, commercial success, long felt but unsolved needs, failure of others, copying by others, licensing, and skepticism of experts).

22. I understand that, prior to the America Invents Act (the “AIA”) of March 16, 2013, the U.S. used a “first to invent” system, whereas the post-AIA U.S. system uses a “first to file” system. I understand this to mean that prior art references and the priority date for pre-AIA patents may be based on whether the claimed subject matter would have been “obvious” to a POSITA as of the priority date of the patent (which may be the first to invent date, not necessarily the filing date) based upon one or more prior art references.

23. I understand that a conclusion of obviousness may be based upon either a single prior art reference or a combination of prior art references, particularly if the combination of elements does no more than yield predictable results. However, I understand that merely demonstrating that each of the claim elements was, independently, known in the prior art does not prove that a patent composed of several claim elements is obvious.

24. Moreover, I understand that it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in a way the claimed new invention does.

25. I further understand that, to determine obviousness, courts look to the interrelated teachings of multiple patents or other prior art references, the effects of demands known to the community or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

26. I also understand that, in determining whether a combination of prior art references renders a claim obvious, it may be helpful to consider whether there is some teaching, suggestion, or motivation to combine the references and a reasonable expectation of success in doing so.

27. I understand that the following exemplary rationales may lead to a conclusion of obviousness: the combination of prior art elements according to known methods to yield predictable results; the substitution of one known element for another to obtain predictable results; and the use of known techniques to improve similar devices in the same way.

28. However, a claim is not obvious if the improvement is more than the predictable use of prior art elements according to their established functions. Similarly, a claim is not obvious if the application of a known technique is beyond the level of ordinary skill in the art.

29. Further, when the prior art teaches away from combining certain known elements, discovery of successful means of combining them is not obvious. I understand that similar subject matter may not be sufficient motivation for a person of skill in the art to combine references if the references have conflicting elements.

30. I understand that, in order to be used in an obviousness combination, a prior art reference must be “analogous.” I understand that a prior art reference may be analogous if it is in the same field of endeavor as the other references with which

it is combined, or if the reference is reasonably pertinent to solving the problems the inventors of the patent-at-issue sought to solve.

31. I understand that obviousness of a patent claim cannot properly be established through hindsight, and that elements from different prior art references, or different embodiments of a single prior art reference, cannot be selected to create the claimed invention using the invention itself as a roadmap. I understand that the claimed invention as a whole must be compared to the prior art as a whole, and courts must avoid aggregating pieces of prior art through hindsight that would not have been combined absent the inventor's insight. I understand that prior art must be enabling.

32. I understand that obviousness is not established merely by showing that each element of a claimed invention was known in the prior art, nor is it established by simply combining known elements. Rather, a claim is unpatentable as obvious if, at the time of the invention, a POSITA would have had a reason to combine or modify the prior art to arrive at the claimed invention, with a reasonable expectation of success.

33. I understand that obviousness of a patent cannot properly be established by mere conclusory statements. Instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness. When an expert opines that all the elements of a claim disparately exist in the prior

art, the expert should provide the rationale to combine the disparate references. A reason for combining disparate prior art references is a critical component of an obviousness analysis. The obviousness analysis should be made explicit and needs to provide an articulated reasoning with some rational underpinning to identify the reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does.

34. I also understand that inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known. This is another reason why merely pointing to the elements being known in the art in separate locations is not the end of the obviousness inquiry.

35. I understand that technical experts may testify to matters like the level of skill in the art at the time of the invention and what a skilled artisan might find obvious in light of the prior art without addressing objective evidence of non-obviousness such as unexpected results, commercial success, long-felt but unsolved needs, failure of others, and the skepticism of experts. However, where an expert purports to testify not just to certain factual components underlying the obviousness inquiry, but to the ultimate question of obviousness, the expert must consider all factors relevant to that ultimate question, including all objective evidence of nonobviousness.

B. Claim Construction

36. I understand that the claim construction exercise begins with the language of the claims themselves, and that the general rule is that claim terms are given their plain and ordinary meaning to a POSITA, in view of the specification of the patent, at the time of the invention. I also understand that the intrinsic evidence (*i.e.*, the claims, the written description including the figures, and the prosecution history) are the primary sources used in interpreting claim language.

37. I understand that even if disputed claim language is clear on its face, the intrinsic evidence should be consulted to determine whether some deviation from the ordinary meaning of the claim language is warranted.

38. When the disputed claim language is not clear on its face, I understand that the intrinsic evidence should be used to resolve, if possible, any lack of clarity. I also understand that the specification is the best evidence of what the patentee intended the term to mean when there is no clear meaning of a claim term, and that the prosecution history may also shed light on the meaning of ambiguous terms. However, I understand that it is improper to import limitations from the specification into a patent claim through claim construction.

39. I have been informed that sometimes the ordinary meaning of claim language as understood by a POSITA may be readily apparent even to lay persons.

I understand that claim construction in such cases involves little more than the application of the widely accepted meaning of commonly understood words.

C. Public Accessibility

40. I understand that for a printed publication to qualify as prior art, it must be publicly accessible.

41. I understand that a reference is considered publicly accessible if a POSITA exercising reasonable diligence can locate it. I understand that whether a reference is publicly accessible depends on the specific facts of the case and is determined on a case-by-case basis.

42. I understand that when a reference is uploaded to a website, part of the inquiry on public accessibility can involve considering whether the reference is indexed or catalogued. I understand that whether a reference was indexed through search engines or could be found through search engines can also be part of the public accessibility inquiry.

D. Inherency

43. I understand that inherency requires inevitability. For example, to be inherent, a result must be inevitable from the operation disclosed. For a characteristic to be inherent, it must be inevitably present in the device. I understand that it is improper to establish inherency if it is only a possibility or a probability that a reference includes the alleged inherent feature. The fact that something may result

from a given set of circumstances is not sufficient to establish inherency. Instead, an inherent feature must be necessarily present in the reference, not probably or possibly present in the reference.

44. I understand that inherency and obviousness are separate inquiries. I understand that what is inherent may not necessarily be known, and what is obvious cannot be predicated on what is unknown.

45. I understand that inherency is a question of fact.

46. I also understand that to turn to inherency, the reference must be silent as to the alleged inherent feature. If a reference discloses subject matter, principles of inherency cannot be used to ignore that explicit disclosure in favor of an alleged inherent disclosure that contradicts the explicit disclosure.

E. Standard of Proof

47. I understand that the standard to prove unpatentability in an *inter partes* review proceeding is by a preponderance of the evidence, which means more likely than not.

IV. METHODOLOGY AND MATERIALS CONSIDERED

48. I have relied upon my education, knowledge, and experience, as well as other materials discussed in this declaration in forming my opinions.

49. For this work, I have been asked to review the '645 Patent including the specification and claims and the '645 Patent's prosecution history (file history).

In developing my opinions related to the '645 Patent, I have considered the materials cited herein, including those items itemized in the Exhibit Table below.

Exhibit	Description
1001	U.S. Patent No. 7,952,645 (“the ‘645 patent”).
1002	File History of U.S. Patent No. 7,952,645.
1003	Declaration of Dr. Dan Schonfeld.
1004	U.S. Patent App. Pub. No. 2004/0156545 (“Kim”).
1005	U.S. Patent No. 5,808,697 (“Fujimura”).
1006	ITU “Recommendation ITU-R BT.1298*; Enhanced wide-screen NTSC TV transmission system” (1997) (retrieved from https://www.itu.int/dms_pubrec/itu-r/rec/bt/R-REC-BT.1298-0-199710-W!!PDF-E.pdf).
1007	Definition of “signal” from <i>Chambers Dictionary of Science & Technology</i> (2007)
1008	Definition of “according to” from <i>The New Oxford American Dictionary</i> (2nd ed. 2005)
1009	Definition of “according to” from <i>Webster’s New College Dictionary</i> (2005).
1010	Definition of “according to” from <i>The Chambers Dictionary</i> (10th ed. 2007).
1011	Patent Owner’s responsive claim construction brief from <i>Maxell, Ltd., v. Lenovo Group Ltd.</i> , No. 6:21-cv-01169 (W.D. Tex. June 13, 2022).
1012	Patent Owner’s sur-reply claim construction brief from <i>Maxell, Ltd., v. Lenovo Group Ltd.</i> , No. 6:21-cv-01169 (W.D. Tex. July 11, 2022).
1013	Patent Owner’s infringement contentions cover pleading from <i>Maxell, Ltd. v. Samsung Elecs. Co., Ltd.</i> , No. 5:25-cv-00052 (E.D. Tex.).
1014	Patent Owner’s ‘645 patent infringement contentions claim chart from <i>Maxell, Ltd. v. Samsung Elecs. Co., Ltd.</i> , No. 5:25-cv-00052 (E.D. Tex.).
2016	Microcontrollers: Fundamentals and Applications with PIC (2009)

V. BACKGROUND OF THE TECHNOLOGY OF THE '645 PATENT

A. Background of the '645 Patent

50. The '645 Patent, titled "Video Processing Apparatus and Mobile Terminal Apparatus," was filed on November 22, 2006, and claims priority to Japanese Application No. 2005-338000 filed November 24, 2005. EX1001, 1:1-10. The named inventors are Kozo Masuda, Ikuya Arai, and Masaaki Miyano, and the patent was assigned to Hitachi, Ltd. EX1001, 1:1-5. The patent issued on May 31, 2011 with eight claims. EX1001, 1:1.

51. The '645 Patent relates to a video processing apparatus and mobile terminal apparatus that improves picture quality while addressing challenges unique to portable devices. EX1001, 1:8-10. At the time of the invention, visual display signal processing posed unique problems for mobile apparatuses with limited processing power and battery life. EX1001, 1:31-37. In particular, correcting the luminance signal and color-difference signal every frame increases power consumption, which is problematic for battery-operated portable devices where opportunities to recharge may not always be available. EX1001, 1:31-37.

52. The specification further identifies that images on mobile devices were difficult to view in varying environments. For example, if sunlight is incident on the display device, it becomes hard to see images, making the mobile terminal apparatus difficult to use outdoors. EX1001, 1:37-40. Additionally, when converting contents

having one aspect ratio (e.g., 4:3) to a video signal having a different aspect ratio (e.g., 16:9), “wallpapers are added to the left and right of the contents sometimes.” EX1001, 1:41-45. If such a video signal is subjected to picture quality correction, the luminance and colors of the wallpaper portions are changed according to the contents of the video signal, and “there is a risk that the image becomes rather hard to watch and the convenience in user’s use becomes worse.” EX1001, 1:45-50.

53. Moreover, if black no-picture areas are added to the left and right sides of the contents, luminance and color information of the black no-picture areas are confused with the content, resulting in a problem that average values of luminance and color of the contents themselves cannot be calculated accurately. EX1001, 1:51-56. The stated object of the invention is therefore “to provide a video processing apparatus and a mobile terminal apparatus improved in convenience in use.” EX1001, 1:57-59.

54. To address these problems, the ’645 Patent discloses a video processing apparatus that includes a detector, which detects whether pattern portions—such as wallpaper portions having a pattern or no-picture area portions having a single color—are contained besides contents in a video signal input thereto, and a corrector, which corrects the video signal. EX1001, 1:60-66. In some embodiments of the ’645 Patent, if the pattern portions are contained in the input video signal, the corrector is controlled so as not to correct the video signal. EX1001, 1:66-67. Conversely, when

pattern portions are not contained, or when black no-picture area pattern portions are contained, some embodiments of the '645 Patent use the corrector to correct the video signal to enhance picture quality. EX1001, 19:52-57; 23:4-12.

55. The '645 Patent describes various embodiments that take various approaches to enhancing picture quality. In a first embodiment, the specification describes a portable telephone including a picture quality enhancement circuit that processes video signals for display. EX1001, 3:32-40. As shown in Figure 1, the portable telephone includes a communication antenna, radio circuit, coding-decoding processing circuit, CPU, memory, TV tuner, display device, picture quality enhancement circuit, and backlight, among other components. EX1001, 3:32-4:16.

56. The picture quality enhancement circuit 15, shown in Figure 2, includes an RGB-YUV converter 151 that converts the video signal from RGB form to a luminance signal (Y) and color-difference signals (R-Y and B-Y). EX1001, 5:23-28. A color difference-HS converter 153 converts the color-difference signals to hue (H) and saturation (S). EX1001, 5:38-42. A characteristic point detector 154 calculates characteristic data—including minimum level, average level, maximum level, and histogram—of the input video signal on the basis of the luminance, hue, and saturation signals. EX1001, 5:41-48. The characteristic point detector 154 writes this characteristic data into an I/F unit 155, which issues an interrupt signal to the CPU 7 at predetermined timing. EX1001, 5:48-50.

57. Upon detecting the interrupt signal, the CPU 7 reads out the characteristic data, determines correction data according to a predetermined algorithm, and writes the correction data into the I/F unit 155. EX1001, 5:50-54. A modulator 152 then conducts modulation based on the correction data on the input luminance signal Y, hue H, and saturation S, and outputs corrected results as luminance Y', hue H', and saturation S'. EX1001, 5:54-57. The specification further describes a scene change detector 1552 within the I/F unit 155 that preserves characteristic data and, upon being supplied with new data, compares it to old data to determine whether a scene change has occurred. EX1001, 9:1-11. If a scene change is detected, the scene change detector issues an interrupt to the CPU 7, which then reads out new characteristic data and generates updated correction data. EX1001, 9:1-11. This scene-change-driven approach reduces processing load and current consumption by avoiding unnecessary updates when the video content has not changed. EX1001, 9:27-33.

58. The specification describes correction processing for luminance, hue, and saturation in detail. For luminance correction, the modulator 152 uses histogram data to determine “blacklevel” and “whitelevel” parameters that define input gradation ranges for which the output gradation is fixed to 0 or 255, respectively. EX1001, 10:14-42. The correction expands the dynamic range of the video signal, making it possible to display an image that is easy to view with clear contrasts while

reducing power consumption. EX1001, 10:42-48. For hue correction, the user can select a color desired to be especially vivid and emphasized, and color correction is conducted on the basis of the selected color and the peak area in the hue histogram. EX1001, 11:60-67. For saturation correction, a saturation gain is applied to emphasize vivid colors when the maximum saturation is below a determinate value. EX1001, 12:26-35.

59. In a second embodiment, the '645 Patent describes a portable telephone that includes a photo sensor 21 for detecting ambient illuminance. EX1001, 13:7-17. The photo sensor allows the apparatus to adjust correction data based on environmental lighting conditions—for example, emphasizing the output gradation on the black side in bright environments so that images can be viewed easily even when sunlight is incident on the display device. EX1001, 14:3-17. The second embodiment also includes an RGB gain adjuster 1510 and describes control of the backlight color temperature using individual RGB LEDs to compensate for the color of surrounding light. EX1001, 14:52-15:44.

60. In a third embodiment, the '645 Patent addresses the detection of pattern portions in the video signal. EX1001, 16:16-31. A pattern portion detector 1511 is added to the picture quality enhancement circuit to detect pattern portions inserted on the left and right of (and/or above/below) an image. EX1001, 16:28-31; 17:18-20. The pattern portion detector includes a horizontal position counter and a

vertical position counter that identify detection points at predetermined positions on the display device. EX1001, 16:44-54. The specification describes disposing detection points in three places (P11, P12, P13) in a pattern portion display area and three places (P21, P22, P23) in a contents display area. EX1001, 17:4-6. By comparing luminance values at these detection points between consecutive frames, the I/F unit 155 determines whether a pattern portion is present. EX1001, 18:24-48. When a pattern portion is detected, the CPU 7 sets correction data to “0.” EX1001, 18:55-61. A POSITA would readily recognize that this means that no correction is performed to any portion of the frame: that is, there is nothing to use to correct, and thus correction of the entire frame is stopped. A POSITA would readily recognize that this saves power, as no processing steps on the frame are taken. Additionally, flicker caused in the pattern portions by changes in luminance and color is prevented, such that the contents are easier to view. EX1001, 19:55-62.

61. In a fourth embodiment, the '645 Patent further distinguishes between different types of pattern portions—specifically, between wallpaper areas (patterned) and black no-picture areas (single color). EX1001, 20:12-26. When pattern portions are detected, the apparatus further determines whether those pattern portions are black no-picture areas by checking whether the luminance signal Y at the detection points is “0.” EX1001, 22:3-11. If the pattern portions are black no-picture areas, the video signal is still corrected, but with specialized correction

characteristics suitable for contents having no-picture area portions—for example, fixing the output for input gradation at or below a certain level to “0” to remove noise contained in the no-picture area portions. EX1001, 22:46-57. Additionally, a characteristic point detection area controller 1512 is provided to restrict the characteristic point detection to only the contents display area, excluding pattern portion areas from the computation. EX1001, 21:25-30, 22:58-66. This ensures that average values of luminance and color of the contents themselves can be calculated accurately without being influenced by the no-picture areas. *Id.*, 1:51-56. In turn, the ’645 Patent ensures that the average values of luminance and color of the contents themselves can be calculated accurately without being influenced by the no-picture areas. EX1001, 22:58-66. That is, while prior implementations might try to correct an entire frame (and thus potentially distort portions of the frame), the fourth embodiment is more nuanced in that it can correct just the content portion of a frame. EX1001, 24:15-16.

62. While the embodiments are described in the context of a portable telephone, the ’645 Patent states that the invention “can be applied to a video processing apparatus, such as a portable telephone, a PHS, a PDA, a notebook computer, a mobile TV, and a mobile video recording apparatus and reproduction apparatus.” EX1001, 3:19-22. The patent also notes that “application of the present invention is not restricted to portable terminal apparatuses” and “may be applied to

any apparatus as long as the apparatus is a video processing apparatus by which a video image can be viewed,” including stationary terminal apparatuses. EX1001, 16:1-8.

63. I note that, particularly given the portability of devices that might implement the innovations of the '645 Patent, a big focus of the '645 Patent is power savings. One of the goals of the '645 Patent is to reduce unnecessary processing (and, in turn, power demand) by carefully limiting enhancement. *Id.*, 1:31-59. Indeed, the very first paragraph of the summary of the '645 Patent notes that increases in “power consumption” can reduce “use time,” thereby “resulting in poor convenience in use.” *Id.*, Later, with respect to the second embodiment (which disables picture correction based on ambient light to save power), the '645 Patent elaborates more about these power savings with respect to portable devices:

Furthermore, since power consumption for the high picture quality display can be made low, the present invention is effective especially for a portable terminal that operates with a battery.

Id., 15:64-16:3; *see also* 15:53-56. I note that, even without such explicit language, a POSITA would readily recognize that the frequent reference to the “mobile terminal apparatus” in the '645 Patent would imply a power-limited environment (due to likely use of a battery) that would require careful consideration of power demand and computational efficiency. In turn, it is my opinion that a POSITA would readily recognize that, in the '645 Patent, there may be instances in which

computationally complex processes (*e.g.*, image enhancement) might be avoided, prioritizing power savings even when such computationally complex processes might be otherwise desirable.

B. Patent Prosecution History

64. The '645 Patent was filed as Application No. 11/602,956, associated with Japanese Application 2005-338000 (filed November 24, 2005).

65. The Examiner allowed claims on January 13, 2011. EX1002, 19.

66. The Notice of Allowability stated: “the prior art does not disclose or suggest applying correction processing to a video signal when non-content pattern data is not detected/contained, and not applying the correction when the pattern data is detected/contained, as is claimed.” EX1002, 21.

C. Level of Ordinary Skill in the Art

67. I understand that claim construction and definiteness are examined through the eyes of a POSITA. I am informed that the factors to be considered in determining the level of ordinary skill in the art are: (1) the education level of active workers in the field, (2) the type of problems encountered in the art, (3) prior art solutions to those problems, (4) the speed with which innovations are made; and (5) the sophistication of the technology in the art.

68. I have also been asked to assume that the relevant time period for determining the level of skill in the art for the '645 Patent is its filing date of

November 22, 2006. The '645 Patent claims priority to an earlier date, November 24, 2005. However, I have been informed that Patent Owner is not relying on the earlier priority date in this proceeding as Fujimura and Kim indicate a publication date prior to either date.

69. In my opinion, a POSITA at the time of the invention would have had a working knowledge of image and/or video processing systems gained through a degree in electrical engineering, computer engineering, or computer science, or an equivalent field, along with approximately two years of experience in image and/or video processing or a related field.

70. As a result of my education and experience, I was at least a POSITA at the time of each of the U.S. filing, the Japanese filing, and the invention of the '645 Patent, and am still a person of at least ordinary skill in the art and have applied the perspective of a POSITA in my analysis.

71. It is my understanding that Dr. Schonfeld contends that a POSITA “would have had a bachelor’s degree in computer science, electrical or computer engineering, or a comparable field of study, plus approximately two to three years of professional experience with image processing, video processing, or other relevant industry experience.” EX1003 ¶ 35. I note that I also qualify as a POSITA under Dr. Schonfeld’s definition of a POSITA.

72. For purposes of this declaration, my opinions would apply under either definition of a POSITA.

D. Claims of the '645 Patent At Issue

73. I understand that the following claims of the '645 Patent are at issue:

'645 Patent Claim Element Number	Claim Text
[1.pre]	A video processing apparatus comprising:
[1.a]	an input unit to which a video signal containing contents is input;
[1.b]	a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit;
[1.c]	a corrector which corrects the video signal input to the input unit; and
[1.d]	a controller which controls the corrector to cause the corrector to correct the video signal input to the input unit when the pattern portions are not contained, and which controls the corrector to cause the corrector not to correct the video signal when the pattern portions are contained.
[2.pre]	The video processing apparatus according to claim 1, comprising:
[2.a]	a characteristic point detector which detects a level or distribution of at least one of luminance, hue and saturation of the video signal,
[2.b]	wherein the corrector corrects the video signal according to the level or distribution detected by the characteristic point detector.
[3.pre]	A video processing apparatus comprising:
[3.a]	an input unit to which a video signal containing contents is input;
[3.b]	a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit;

'645 Patent Claim Element Number	Claim Text
[3.c]	a characteristic point detector which detects a level or distribution of at least one of luminance, hue and saturation of the video signal input to the input unit;
[3.d]	a corrector which changes correction characteristics according to a result of detection output from the characteristic point detector, and corrects the video signal input to the input unit; and
[3.e]	a controller which controls the corrector to cause the corrector not to change the correction characteristics in the corrector when the pattern portions are contained.
[4]	The video processing apparatus according to claim 1, wherein the pattern portions are wallpaper areas or no-picture areas having a single color added to left and right of the contents or above and below the contents and displayed.
[5.pre]	A video processing apparatus comprising:
[5.a]	an input unit to which a video signal containing contents is input;
[5.b]	a pattern portion detector which detects whether a pattern portion other than contents is contained in the video signal input to the input unit;
[5.c]	a no-picture area detector which detects whether the pattern portions are no-picture areas having a single color;
[5.d]	a corrector which corrects the video signal input to the input unit; and
[5.e]	a controller which controls the corrector to cause the corrector to correct the video signal input to the input unit when the pattern portions are not contained and when the pattern portions are the no-picture areas, and which controls the corrector to cause the corrector not to correct the video signal when the pattern portions are not the no-picture areas.
[6.pre]	The video processing apparatus according to claim 5, comprising:
[6.a]	a characteristic point detector which detects a level or distribution of at least one of luminance, hue and saturation of the video signal,

'645 Patent Claim Element Number	Claim Text
[6.b]	wherein when the no-picture area detector has detected that the pattern portions are no-picture areas, the characteristic point detector detects a level or distribution of at least one of luminance, hue and saturation of the video signal other than the no-picture areas.
[7]	The video processing apparatus according to claim 5, wherein the pattern portions are portions added to left and right of the contents or above and below the contents and displayed.
[8]	The video processing apparatus according to claim 5, wherein the no-picture areas have a black color or a white color.

VI. CLAIM CONSTRUCTION FOR THE '645 PATENT

74. For any terms not specifically construed, I have applied the ordinary and customary meaning that these terms would have had to a POSITA at the time of the invention (around late November 2005) in view of the patent's specification. In other words, I have interpreted the remaining terms in accordance with the "plain and ordinary" meaning.

A. "video signal" (claims 1-3, 5-6)

75. Petitioner and Dr. Schonfeld contend that the plain and ordinary meaning of video signal "includes a logical unit of video." EX1003 ¶ 39. Petitioner and Dr. Schonfeld further define "logical unit" to comprise a frame or a scene. EX1003 ¶¶ 39-41. I understand their construction to mean that a video signal can comprise a logical unit which comprises a frame or a series of frames that include a

relationship (*e.g.*, consecutive frames). That said, as I discuss later, this construction in the Petition appears to be used to argue that the “*video signal*” also encompasses other logical units of video, such as horizontal scan lines or even a full video content item (like an entire movie or TV show).

76. I disagree with Petitioner’s and Dr. Schonfeld’s position and instead posit that the correct construction of “*video signal*” is “a frame or series of related frames, such as a scene.” As it is used in the ’645 Patent (*e.g.*, with respect to the scene change detector), a POSITA would recognize that “scene” could include a portion of some video that would be captured by one or more video frames, like how a series of video frames might be used to depict a scene in a television show. A primary way that my definition differs from that proffered by Dr. Schonfeld is that my definition is tied directly to the disclosure of the ’645 Patent, which only describes logical units of video in the context of a frame or plurality of frames (which, again, might be of a single scene). That is, I do not agree with the overbroad argument that the “*video signal*” as recited in the claims could be met by any possible “logical unit of video,” such as the full video content item or individual scanning lines as applied in the Petition.

77. My definition of “*video signal*” respects the actual structure of the claims and is far more faithful to the disclosure of the ’645 Patent. Claim 1, for example, recites “*video signal containing contents*” and detecting “*whether pattern*

portions other than contents are contained in the video signal input to the input unit.”

This, standing alone, suggests that the “*video signal*” must be more than just a singular scanning line or pixel because it must be capable of including both “*pattern portions*” and “*contents*.” In the context of the ’645 Patent, a POSITA would not find it obvious for a pixel or horizontal scanning line to contain both “*contents*” and “*pattern portions*” without a broader understanding of the entire frame within which that pixel/horizontal scanning line exists, meaning that the entire frame is the relevant unit of video. In addition, the ’645 Patent is consistent in exclusively treating the relevant “*video signal*” as, at minimum, a single frame. *See, e.g.,* EX1001, 16:16-21 (“If the video signal with the pattern portions added is subjected to picture quality correction by taking a frame as the unit or a scene as the unit...”). Moreover, there is not a single part of the ’645 Patent that would teach a POSITA to consider an entire video as the claimed “*video signal*,” nor does it describe (in, *e.g.,* the third embodiment) that single scanning lines are analyzed in isolation. *Id.*, 16:7-20:10. Even the fourth embodiment in the ’645 Patent, which provides significant detail, does not support the idea that the “*video signal*” is anything other than a frame or series of frames. *See Id.*, 20:14-24:42.

78. In turn, I disagree with Petitioner and Dr. Schonfeld that the definition of “*video signal*” can be flexibly re-defined as, for example, a horizontal scan line. Pet. 37. While scan lines, pixels, frames, scenes, and the like might all be part of a

video, the '645 Patent exclusively uses this term to refer to a frame or series of related frames, such as a scene. To permit “*video signal*” to include other material (e.g., horizontal scan lines) would be nonsensical to a POSITA at least because identifying a “*pattern portion*” in a horizontal scan line in conjunction with “*contents*” would be difficult, if not nearly impossible to do without information about the totality of a frame. In other words, while there might be many different components of video at different levels of description (e.g., voltage levels, scan lines, fields, frames, synchronization signals, pixels, shots), the '645 Patent is clear that it operates on a frame or series of related frames: that is, the decision to correct or not correct has always been made at the frame level.

79. Two brief examples help illustrate how Petitioner’s construction is overly broad. On one hand, assume the “*video signal*” includes a horizontal scan line. Here, the system would purport to “*detect[] whether pattern portions other than contents are contained in the video signal input to the input unit.*” But it is not clear how this would actually be performed without far more context (and the '645 Patent is little help, as it never deals with horizontal scanning lines in this context). After all, if the scan line begins blue and ends red, it could include “*pattern portions*” (e.g., because they are all blue) or not. Making such a distinction would require far more information about the frame as a whole. That is, knowledge of other scan lines—and, indeed, the totality of the frame—would be necessary, illustrating how the

horizontal scan line cannot be the relevant “*video signal*.” On the other hand, assume the “*video signal*” is an entire television show or movie comprising thousands and/or millions of frames. The inquiry as to whether “*pattern portions other than contents are contained in the video signal input to the input unit*” would be reduced to an inquiry as to whether some portion of the movie (say, a title card scene) had a pattern portion relative to other portions (such as an action scene). But it would make no sense to use the absence or presence of a title card to affect whether the action scene should, for example, be color corrected.

80. Accordingly, “*video signal*” would be interpreted by a POSITA as a frame or series of related frames, such as a scene. That said, although I disagree with Dr. Schonfeld’s position, I have considered both claim construction approaches in my analysis below.

B. “a corrector which corrects the video signal input to the input unit” (claims 1 and 5)

81. Leveraging litigation activity, Petitioner and Dr. Schonfeld contend that these may be “means-plus-function elements and that their corresponding structure is ‘CPU 7 or equivalents thereof.’” EX1003 ¶ 42. Petitioner and Dr. Schonfeld further claims to address both the plain meaning interpretation and a means-plus-function interpretation of these claim elements where the corresponding structure is “CPU 7 or equivalents thereof.” EX1003 ¶ 43. I have considered both possible constructions (the plain meaning and means-plus-function interpretations) of these

claim elements in my analysis below. As provided below with respect to each ground, my analysis and conclusions offered below are valid under either possible construction.

C. “correct[s] the video signal” (claims 1-3, 5-6)

82. It is my opinion that “*correct[ing] the video signal*” should be construed to mean applying a correction to a video frame or series of frames (frame, series of related frames), with the term “*not correct[ing]*” meaning not applying a relevant correction to the logical unit (*e.g.*, not applying chrominance or luminance corrections to a frame or series of related frames).

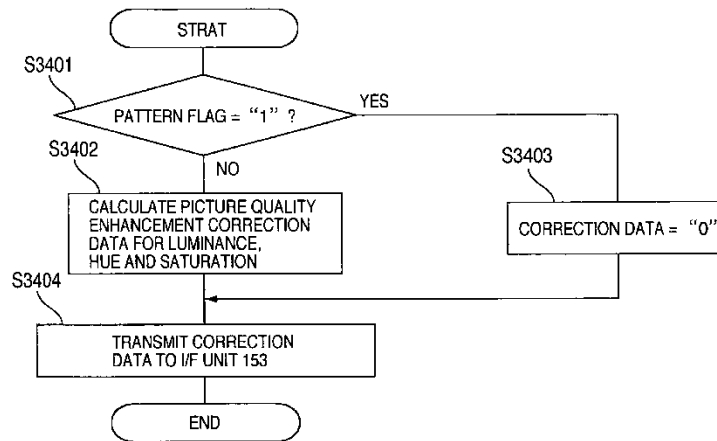
83. Dr. Schonfeld contends that “[i]n [his] opinion, a POSITA would have understood this claim element to include correcting *part of* the video signal.” EX1003 ¶ 44. Dr. Schonfeld supports this construction by pointing to specification embodiments in which only part of the video signal is corrected, such as correction values of zero for certain gradation areas. EX1003 ¶ 45.

84. As a preliminary matter, I note that both Petitioner’s and Dr. Schonfeld’s approach to “*correct[ing] the video signal*” hides a key distinction: there is a significant difference between “*correct[ing]*” and “*not correct[ing]*.” It is my opinion that a POSITA would understand that, given the disclosure of the ’645 Patent, “*not correct[ing]*” is beneficial to, among other things, avoid improper corrections (*e.g.*, over-correcting images) and to reduce the power requirements that

might be imposed on a mobile device. EX1001, 19:58-63; 15:57-67. For example, when a pattern portion is detected in a frame, one approach described by the '645 Patent is to set a value that disables relevant corrections to the frame(s). *Id.*, 18:58-61; 19:52-57. Relevant corrections (*e.g.*, to luminance, chrominance) that might be applied to that frame are not applied to the frame or any portion of it. A POSITA would recognize that, by not performing those relevant corrections, the power savings extolled by the '645 Patent are achieved because additional processing steps inherent to those correction(s) are avoided. Those power savings would not be realized if, for example, “*not correct[ing]*” were somehow read to be satisfied if a frame was still corrected, but some portion of that frame remained substantially the same. After all, in that case, processing steps would still be performed. I note that this construction does not rule out that entirely other corrective processes might perform processing steps: after all, entirely different corrective processes might operate to process the video (to, *e.g.*, prepare it for display by decoding it from some other format). Those processes might be unavoidable or worth the power cost (*e.g.*, because without such decoding the video wouldn't be able to be displayed in the first place). That said, the present claims are clear that “*not correct[ing]*” means that the relevant corrections (*e.g.*, to luminance, chrominance) are not applied to the totality of the frame: the system skips the computational labor in its entirety.

85. It is my opinion that the disclosure of the '645 Patent itself proves that “*not correct[ing]*” a video signal involves not making relevant to the totality of a frame or series of related frames. The first claim of the '645 Patent recites a “*detector*” which “*whether pattern portions other than contents are contained in the video signal input to the input unit*” and later a “*controller*” which “*controls the corrector to cause the corrector not to correct the video signal when the pattern portions are contained.*” The language thus indicates that the “*video signal*” contains at least “*contents*” as well as possibly containing “*pattern portions*,” but specifically requires “*caus[ing] the corrector not to correct the video signal when the pattern portions are contained.*” A POSITA would readily recognize that the correction is required to be made to the “video signal,” not just to the “*contents*” or the “*pattern portions*.” This is a reference to a very specific approach taken by the '645 Patent, as shown in (for example) its third embodiment. EX1001, 16:5-20:10. Take, for example, Figure 34 of the '645 Patent, which relates to that third embodiment:

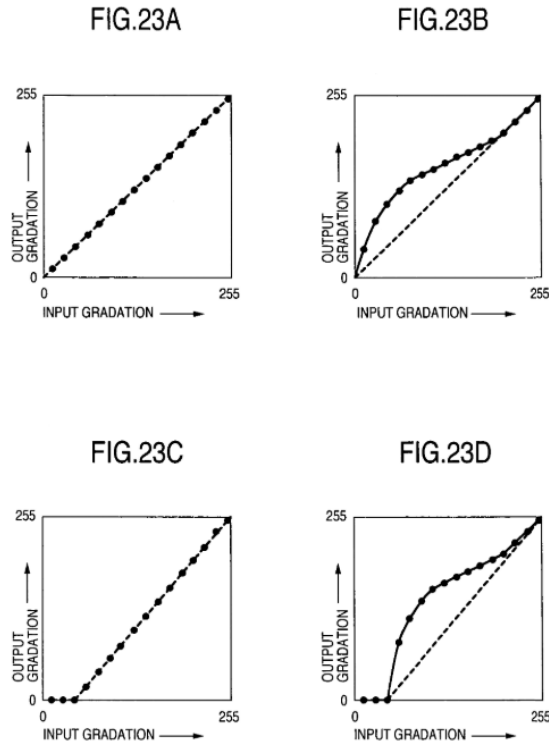
FIG.34



EX1001, FIG. 34. Figure 34 clearly depicts that, if a pattern flag is set to “1,” correction (such as might be effectuated via the “picture quality enhancement correction data” referenced in step S3402) is not performed, and the computational effort inherent in that process is avoided. *Id.* That is, nothing happens, and power is saved. This is squarely one of the examples of the ’645 Patent: as it describes early in its summary section, “[i]f the pattern portions are contained in the input video signal, the corrector is controlled so as not to correct the video signal.” *Id.*, 1:65-67. The ’645 Patent does discuss other approaches to this process (such as in the fourth embodiment which is more complex at least in that it addresses patterns that may or may not be wallpaper portions), but a POSITA would recognize that those other approaches are not what the claim language is referring to. *See Id.*, 20:14-25. After all, the ’645 Patent describes a wide variety of possible improvements and variations on how correction might be implemented, and it would be abundantly clear to a

POSITA that the claims of the '645 Patent are directed to one of those approaches (specifically, not applying a relevant correction in certain circumstances at least because doing so would save power). *Id.*, 24:14-16, 20:61-64. In other words, it is clear to me (and would be clear to a POSITA) that, among the different approaches described in the '645 Patent, the '645 Patent claims specifically select one of those approaches where whole-frame correction is performed or not performed such that, when a pattern is detected, relevant corrections are skipped. To assert otherwise would not achieve the many power savings benefits extolled by the '645 Patent.

86. That said, with respect to affirmatively “*correct[ing] the video signal*,” I do not disagree with Dr. Schonfeld that the '645 Patent describes various examples of how video signals might be corrected (and may well support a variety of corrections to different parts of a “*video signal*”). I also agree that the “*correct[ing] the video signal*” may ultimately result in some portions of a corrected frame being changed while others are not. Take, for example, Dr. Schonfeld’s reference to Figures 21 and 23A-D insofar as he contends that he suggests that they involve correcting only portions of the frames of a video signal:



Id., FIGs. 23A-D. A POSITA would understand that these curves show various options of how input gradations might be corrected to create different output gradations: for example, gradations in the middle of the spectrum might be darkened or lightened as desired. These curves are merely a set of rules of how, for some gradation (*e.g.*, luminance and/or chrominance value for a video signal), input might be modified to, for example, enhance video output. This certainly might mean that some portions of a video signal might remain the same, but it does not suggest that the correction targets specific portions of and/or locations in a frame. To the contrary, these curves are examples of rules how, once the '645 Patent system has decided to perform correction(s) to an entire frame (and incur the power cost of

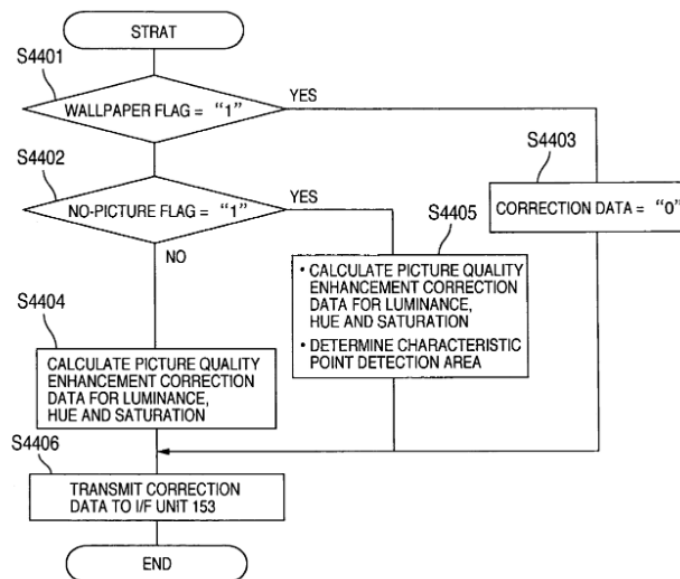
doing so), such corrections might be implemented across the entire frame, although the net result is that some portions of the frame might remain substantially the same.

87. Accordingly, while I might agree with Petitioner and Dr. Schonfeld that the '645 Patent discloses a variety of ways that correction might occur, I emphasize that the claims explicitly require (and would be recognized by a POSITA to require) “*not correct[ing]*” an entire frame or series of frames so as to achieve the very purpose of the '645 Patent. In the context of claim 1, this would mean that “*cause the corrector to correct the video signal input to the input unit when the pattern portions are not contained*” and “*cause the corrector not to correct the video signal when the pattern portions are contained*” are akin to that depicted in FIG. 34: that is, when “*pattern portions are contained*,” a relevant correction is not performed on any portion of the frame; while, when “*pattern portions are not contained*,” a relevant correction occurs (and is applied to the whole frame, although the result might mean that some parts of the frame remain similar to their previous versions).

88. Claim 5 takes a slightly different approach than claims 1 and 3 but still uses “*not . . . correct[ing] the video signal*” in a manner which means an otherwise-planned correction is not performed for an entire frame or series of related frames. Claim 5 recites “*cause the corrector to correct the video signal input to the input unit when the pattern portions are not contained and when the pattern portions are the no-picture areas*” and “*cause the corrector not to correct the video signal when*

the pattern portions are not the no-picture areas.” Critically, the language still recites “*correct the video signal*” and “*not to correct the video signal,*” even if the “*when*” clauses governing correction/non-correction are different. In this case, claim 5 in some ways acts as a hybridization of the third embodiment and the fourth embodiment: if (1) pattern portions are not contained or (2) the pattern portions are contained and are no-picture areas, then correction occurs. In contrast, if the pattern portions are not the no-picture areas (and are, for example, a wallpaper or the like), correction does not occur to the frame. Figure 44 depicts precisely that no-correction case where “Correction Data = ‘0’” is clearly shown in step S4403:

FIG.44



EX1001, FIG. 44. That said, note that this claim takes a slightly different approach to what I’ve described above: the power savings are when a “wallpaper” is identified, but they are not achieved when a “no-picture flag” is set. Even in this slightly

different implementation, “*not . . . correct[ing] the video signal*” still means not making changes to frame(s). That is, a POSITA would still recognize that, even with this relatively more complex approach, the presence of a wallpaper would cause no correction to occur whatsoever to one or more frames. After all, as is the case with claims 1 and 3, to read differently would be to flout the entire purpose of the power savings extolled by the ’645 Patent.

89. I also note that a POSITA would readily recognize that, if the claims did intend to suggest additional nuance (*e.g.*, targeting correction for only “*contents*,” interpreting “*not correct[ing]*” as only not correcting some portion of a frame), it would have claimed as much. Thus, even if Dr. Schonfeld were correct that some of the ’645 Patent suggests “*correct[ing]*” only part of a video signal, that does not mean that “*not correct[ing]*” is performed if it can be proven that some small portion of a frame remains the same post-correction. If the ’645 Patent meant to say that in the claims, it would have done so. After all, it would have been inconsequentially easy to state, in the claims, “*not correct[ing]*” by only correcting the “*contents*” or the like.

90. Despite my many concerns regarding Petitioner’s and Dr. Schonfeld’s construction of these terms, I have considered both interpretations in my analysis below, and my opinions and conclusions are the same for both. I also reserve the

right to rebut any additions or changes to Petitioner’s and/or Dr. Schonfeld’s construction of this term.

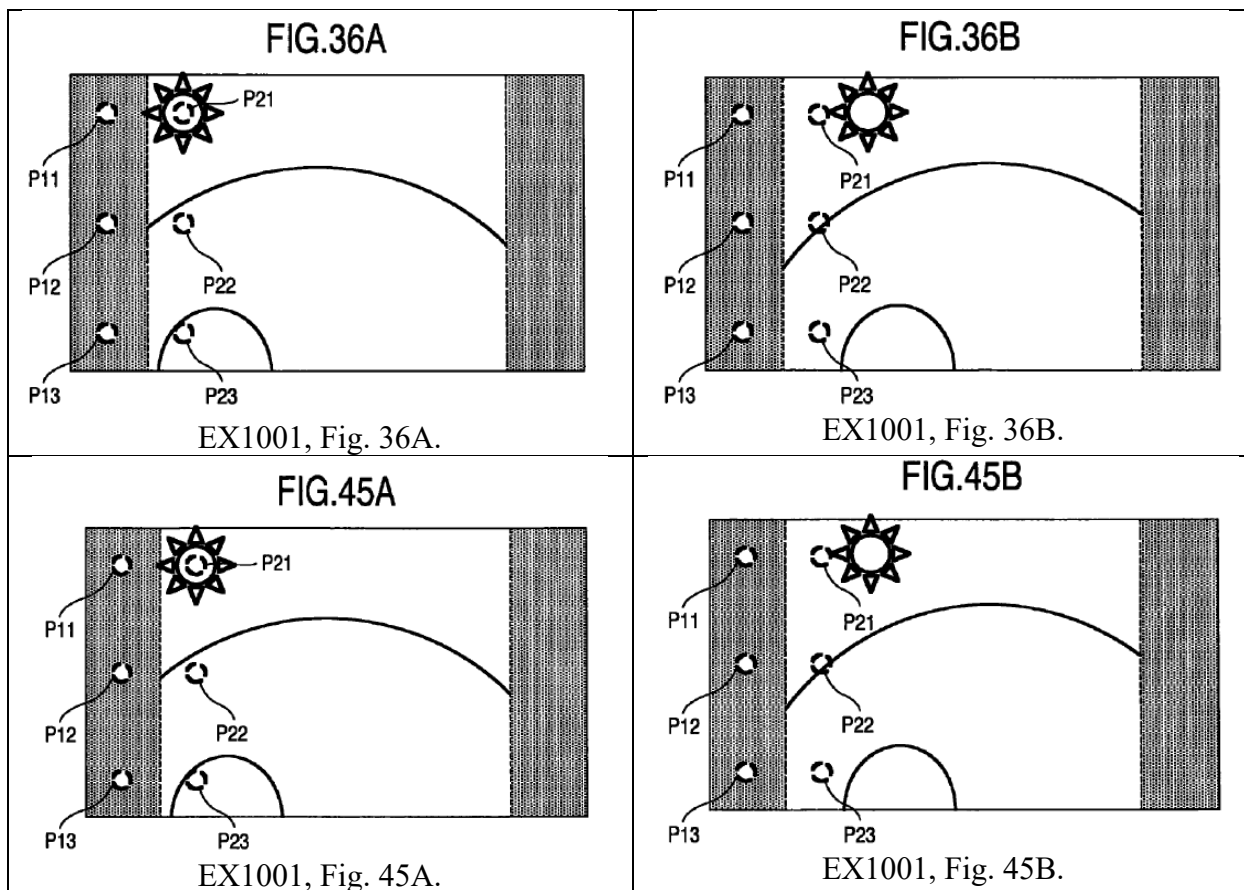
D. “the pattern portions are contained” (claims 1 and 3); “the pattern portions are not contained” (claims 1 and 5)

Patent Owner’s Construction	Petitioner’s Construction
Frame always contains “contents,” inquiry is to whether “pattern portions” are contained in that same frame or not	“the plain meaning of these claim limitations means the pattern portions are included in the video signal and the pattern portions are not included in the video signal, respectively” (Pet. 8)

91. It is my opinion that the claims as written, in view of the ’645 Patent, clearly indicate that the relevant inquiry as to whether the “*pattern portions*” are or are not contained specifically relate to whether a frame contains those “*pattern portions*” along with “*contents.*” That is, the claims require that the frame(s) contain “*contents,*” the question is whether it contains “*pattern portions.*” After all, a POSITA would recognize that “*pattern portions*” implies the existence of other portions; that is, the already-present “*contents.*” That decision might be made based on comparing the current frame to a preceding frame (*e.g.*, to determine whether the “*pattern portion*” is some part of the frame that remains unchanged relative to the preceding frame), but the relevant question still relates to a single frame. In turn, I strongly disagree with Petitioner’s and Dr. Schonfeld’s proposed “plain” meaning of these terms, which seem to suggest that the only relevant inquiry relates to

whether the “pattern portions are included” or not included in the “*video signal*” writ large. That approach would seemingly allow for “*pattern portions*” in any portion of a video signal (*e.g.*, in one frame) to somehow cause correction of an entirely different portion of the video signal (*e.g.*, in an entirely different frame minutes/hours/days later), which would be completely different from how the ’645 Patent operates.

92. In my opinion, a POSITA would readily recognize that the ’645 Patent discusses “*pattern portions*” as something that may or may not occur in the same frame as “*contents*.” Based on my review, the ’645 Patent never indicates that “*pattern portions*” somehow could comprise an entire frame of their own. Nor does the ’645 Patent indicate that “*pattern portions*” in one frame would cause correction of “*contents*” in an unrelated frame. Rather, a POSITA would recognize that everything in the ’645 Patent is done on a per-frame basis, with the frame containing “*contents*” and possibly also containing “*pattern portions*.” The ’645 Patent provides examples, such as those in FIGs. 36A-D, where the “*pattern portions*” are black bars forming letterboxed regions around “*contents*” in the frame:



Indeed, every reference in the '645 Patent to these “*pattern portions*” suggest that they are “*portions*” of a frame in addition to “*contents*” in that same frame. For example, the '645 Patent describes how “*pattern portions*” may be added to the same frame as the “*contents*” to pad out a particular aspect ratio (EX1001 16:7-15) and describes that a detector is added to “detect pattern portion inserted on the left and right of an image.” *See, e.g., Id.*, at 16:28-31; *see also, e.g., id.*, 17:11-16, 19:28-30, 20:17-22. There is nothing in the '645 Patent that would lead me (or any other POSITA) to believe that, for example, the “*pattern portions*” and the “*contents*” could be in different frames. Nor is there anything in the '645 Patent that would lead

me (or any other POSITA) to believe that “*pattern portions*” in one frame would result in a different frame without “*pattern portions*” being corrected. After all, had such a concept been contemplated, a POSITA would need far more information to know how to implement such a system: for example, how to correlate disparate frames, or the like.

93. Critically, I note that the ’645 Patent’s use of a preceding frame to detect whether a given frame contains “*pattern portions*” does not imply that the “*pattern portions*” can be in an entirely different frame from the “*contents*.” The ’645 Patent describes how the “*pattern portions*” might be detected by determining (for example) if different detection points on one frame have a “difference from the preceding frame.” EX1001 18:14-49. For instance, the ’645 Patent refers to: (1) “one frame” multiple times when describing detector functions (*see, e.g.*, EX1001, 6:44-45, 8:11-12); (2) “taking a frame as the unit” multiple times when describing the detector functions (*see, e.g.*, EX1001, 6:67-7:3); (3) “preceding frame” multiple times when describing detector functions (*see, e.g.*, EX1001, 9:35-37, 18:20-22); and (4) “consecutive frames” multiple times when describing detector functions (*see, e.g.*, EX1001, 20:5-9). These portions merely indicate that a preceding frame might be used to determine whether a current frame has “*pattern portions*.” It is my opinion that a POSITA would readily recognize that the relevant inquiry for whether to correct a frame relates to whether (for example) the frame, already containing

“*contents*,” also contains “*pattern portions*.” These portions of the ’645 Patent do not remotely contemplate that, for example, “*pattern portions*” in one frame might cause an entirely different frame comprising only “*contents*” to be corrected.

94. In turn, I disagree with Petitioner’s and Dr. Schonfeld’s proposed construction, which suggests that pattern portions and content need not be in the same frame. EX1003 ¶ 47. In my view, the ’645 Patent is clear that the relevant inquiry regarding whether to correct a particular frame is, for example, whether that frame (which already contains “*contents*”) also contains “*pattern portions*” (and, in the context of claim 5, whether the “*pattern portions*” are “*no-picture areas*”). A preceding frame might be used to identify the presence of “*pattern portions*” in the frame of interest, but this does not mean that (for example) a preceding frame can exclusively comprise a “*pattern*” and then somehow affect some subsequent frame exclusively comprising “*contents*.” Dr. Schonfeld’s approach would result in a variety of different issues. For example, Dr. Schonfeld’s proposed construction does not specify how one frame with a “*pattern*” might somehow affect another frame with “*contents*” —for example, there’s basically no time limit specified between the frames. I also note that he seems to sometimes avoid using the term “*portions*” in quoting the claims (*See, e.g.*, EX1003 ¶¶ 66-68.), which misconstrues the claims: a POSITA would recognize that the language “*portions*” is very intentionally used to specify that the frame contains both “*contents*” and “*pattern*” portions.

95. I also disagree with Petitioner’s and Dr. Schonfeld’s insinuation that the third embodiment’s stopping of “enhancement processing” somehow changes the interpretation of these features. I note that the third embodiment of the ’645 Patent involves stopping “enhancement processing” at “the time of display of [the] pattern portions.” EX1001, 19:52-57; *see also Id.*, 19:59-61, 19:67-20:1. But a POSITA would just read this to mean that, for a frame that contains both “*content*” and detected “*pattern portions*,” enhancement would not be applied. That doesn’t change anything about the per-frame approach I describe above.

96. It is further my opinion that allowing “*pattern portions*” in one frame to affect the correction in a different frame defeats the purpose of the ’645 Patent. The “object of the present invention” described by the ’645 Patent is to address video signal correction when patterns are in a frame, such as where color correction might be performed in the context of different aspect ratios and/or in the presence of wallpaper-like images. EX1001, 1:41-56, 1:57-59. Allowing “*pattern portions*” in one frame to affect another would not achieve this goal and raises more questions than it answers: for example, it’s unclear how the two frames might need to be related temporally.

97. In view of the foregoing, Petitioner and Dr. Schonfeld’s overly broad interpretation of the claimed term finds no support in the intrinsic record and should be rejected. Instead, the claims should be interpreted as they are written and as a

POSITA would understand them: the relevant inquiry as to whether the “*pattern portions*” are or are not contained specifically relate to whether a frame contains those “*pattern portions*” along with “*contents*” in that frame.

E. “when the pattern portions are contained” (claims 1 and 3); “when the pattern portions are not contained” (claims 1 and 5); “when the pattern portions are not the no-picture areas” (claim 5)

98. I have reviewed Petitioner’s and Dr. Schonfeld’s arguments regarding “*when*” and similar terms as used in these features and generally have not identified in their arguments any proper definition of how those terms as would be understood by a POSITA.

99. Petitioner’s and Dr. Schonfeld’s declaration purport to use a “broader” interpretation of the term “*when*” in the context of the claims. It is not particularly clear to me what that means. They appear to justify this construction based on litigation activity, which involved a system capable of selecting a “Food” or “Portrait” mode for a camera. To the extent that I understand their position at all, I disagree with this interpretation of how this litigation activity affects the word “*when*” as used in these claims. As I understand it, when (for example) a “Food” mode is selected in the relevant system, the system then tries to detect food. It is not clear to me how that functionality requires that “*when*” mean “whenever.” In fact, I’m not particularly sure how this concept supports a “broader” interpretation, nor what that broader interpretation would mean.

100. Regardless of how “*when*” is construed, I note that the Petition is very inconsistent with how it interprets “*when*.” I note that, in Ground 2, Petitioner argues that Fujimura’s vertical limiter causes correctors “not to enhance (correct) the luminance of the pixels of a scanning line (video signal) when the scanning line contains pattern portions.” Pet. 48. That said, this approach contradicts Petitioner’s arguments regarding Ground 3, where Petitioner states that, in the case “when the pattern portions are the no-picture areas,” Fujimura’s “corrector enhances the picture area portion of the image (i.e., the picture area part of the video signal) and therefore still corrects the image (video signal).” Pet. 67. In this way, Petitioner seems to argue that the same scenario (enhancing a “picture area” and not enhancing the “non-picture bands above and below” the picture area) is both: (1) “caus[ing] the corrector not to correct the video signal when the pattern portions are not the no-picture areas” (limitation [1.d]); and (2) “caus[ing] the corrector to correct the video signal input to the input unit . . . when the pattern portions are the no-picture areas” (limitation [5.e.i]). That is, Petitioner argues the same scenario of not correcting the black-picture band areas can be construed as both (1) the corrector does not correct the video signal because the black-picture bands are not corrected; and (2) the corrector does correct the video signal because at least a portion of the video signal is being corrected. This approach introduces even more ambiguity regarding “*when*,” and it is not quite clear to me that a POSITA would find it straightforward.

F. “a characteristic point detector” (claims 2-3, 6)

101. Dr. Schonfeld states that a POSITA would have understood “*characteristic point detector*,” in view of the ’645 Patent specification, to include a component that determines a histogram of luminance from an input video signal. EX1003 ¶ 50. I note that this approach does appear unnecessarily limiting insofar as a “*characteristic point detector*” could, given the ’645 Patent, be used to calculate a variety of things, such as a minimum, maximum, average, and/or histogram of luminance, hue, saturation, and the like. That said, I adopt Petitioner’s construction in my approach herein where relevant.

G. “a result of detection output from the characteristic point detector” (claim 3)

102. I disagree with the construction provided by Petitioner and Dr. Schonfeld for this term because, in my view, they misread the applicable language, both in terms of basic grammar as well as in terms of how a POSITA would understand the language.

103. Dr. Schonfeld states that the plain meaning of this claim element includes a “result” that is not “from the characteristic point detector” but still is a result of “detection output” that is from the characteristic point detector. EX1003 ¶ 51. In my opinion, this interpretation of the claim language misconstrues the basic grammar of the claims. It is important to consider the language of the clause in full: “*a corrector which changes correction characteristics according to a result of*

detection output from the characteristic point detector.” This language, like other parts of the ’645 Patent claims (e.g., “*a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit*”), uses a past tense verb to modify preceding words. That is, the “*result of detection*” was “*output from the characteristic point detector,*” much like how the “*video signal*” was “*input to the input unit.*” This grammatical construction is thus similar to a sentence like “Bob drank the wine of Italy poured from the bottle”: the correct reading is that “poured” modifies “wine of Italy.” Dr. Schonfeld’s approach misreads this feature in a way that, returning to my example above, suggests that the sentence would be read as suggesting that the country of Italy was poured from the bottle and that the wine was somehow generated based on Italy but not necessarily from the bottle. Such a strained reading of the claims is not remotely reasonable and would certainly not be how a POSITA would understand the claims.

104. Petitioner’s and Dr. Schonfeld’s construction is also incorrect in view of the express disclosure of the ’645 Patent. The ’645 Patent is replete with examples of how the “*result of detection*” is output from the “*characteristic point detector.*” For example, I note that, early in the ’645 Patent, it discusses how the “characteristic point detector 154” calculates “characteristic data”:

A characteristic point detector **154** calculates characteristic data such as a minimum level, an average level, a maximum level and a histogram of the input video signal on the basis of the luminance signal Y input from the RGB-YUV converter **151** and the hue H and the saturation S

input from the color difference-HS converter **153**. The characteristic point detector **154** writes the characteristic data into an I/F unit **155**. The I/F unit **155** issues an interrupt signal **141** to the CPU **7** at predetermined timing. Upon detecting the interrupt signal **141**, the CPU **7** reads out the characteristic data stored in the I/F unit **155** via an internal bus **1551**, determines correction data according to a predetermined algorithm, and writes the correction data into the I/F unit **155** via the internal bus **1551**.

EX1001, 5:41-54. It then clarifies that this “characteristic data” is used by the CPU to “read[] out the characteristic data” and determine correction data based on that characteristic data. *Id.* In other words, a POSITA would readily recognize that, based on the ’645 Patent, the language should be read as a “*result of detection*” (e.g., the characteristic data) being “*output from the characteristic point detector.*”

105. It is also my opinion that Petitioner’s and Dr. Schonfeld’s alleged “plain meaning” of this feature introduces ambiguity to the claims. The proposed approach seems to suggest that the “result” is not from the “characteristic point detector,” but is somehow still a “result of ‘detection output’ that is from the characteristic point detector.” Pet. 11. It thereby suggests that there is some other, non-specified device that generates a “result,” and that the relevant clause is “detection output” (which, it seems, is an awkward way to describe the characteristic data). But it is not clear to me (and it would not be clear to a POSITA) what the “*result*” would be versus the “*detection output,*” and it is especially unclear what the unidentified additional device(s) would be providing such a “*result.*” And, critically, the ’645 Patent does

not support this strained interpretation of the claims, so it doesn't help answer those questions.

106. In view of the foregoing, it is my opinion that the Board should reject Petitioner's and Dr. Schonfeld's overly broad interpretation that finds no support in the intrinsic record. That said, I adopt this construction in my approach herein where relevant.

H. "a corrector which changes correction characteristics according to a result of detection output from the characteristic point detector" (claims 1-3, 5-6)

107. Dr. Schonfeld states that the plain and ordinary meaning of the phrase "*according to*" in this claim element includes that the "*corrector*" can change "*correction characteristics*" based in part on "*a result of [the] detection output,*" rather than accordingly only to the result of the detection output. EX1003 ¶ 52. I note that Dr. Schonfeld's attempt to broaden "*according to*" to mean merely "based in part on" is unsupported by the intrinsic record and would improperly expand the scope of the claim beyond what the '645 Patent discloses. Indeed, it is not particularly clear to me that a POSITA would recognize what additional factors would be at play if a construction like "based in part on" were used. A plain and ordinary meaning of such language would be far more accurate to how it is used in the '645 Patent. Regardless, I adopt this construction herein where relevant.

108. As an aside, I note that the Petition appears to confuse the “*detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit*” (e.g., in claim 1) with the “*characteristic point detector which detects a level or distribution of at least one of luminance, hue and saturation of the video signal*” (e.g., in claim 2). These are different elements of the claims, and a POSITA would recognize that they perform different functions and would involve different structures. That is, it would be manifestly improper to argue that the same element was both (for example) the “*detector*” in claim 1 and the “*characteristic point detector*” in claim 2.

I. “cause the corrector not to change the correction characteristics in the corrector when the pattern portions are contained” (claim 3)

109. Petitioner and Dr. Schonfeld assert that a POSITA would have understood that the claim language “*not to change the correction characteristics ... when the pattern portions are contained*” should be interpreted to include setting the correction characteristics to one or more constant values (*i.e.*, values that do not change) every time “*the pattern portions are contained.*” EX1003 ¶ 54. I note that, to the extent these construction attempts to expand this term to encompass scenarios not supported by the ’645 Patent, I disagree with such expansion. A plain and ordinary meaning of such language would be far more accurate to how it is used in the ’645 Patent. Regardless, I adopt this construction herein where relevant.

VII. SUMMARY OF PETITIONERS' PROPOSED GROUNDS

110. In my review of the Petition and Dr. Schonfeld's declaration, they allege that claims 1-8 of the '645 Patent would have been obvious under pre-AIA 35 U.S.C. § 103 and raises three grounds of alleged unpatentability. EX1003 ¶ 3. The alleged invalidity grounds are summarized as follows:

Ground	'645 Claims	Type of Challenge	References
1	1-3	§ 103	Kim
2	1-4	§ 103	Fujimura
3	5-8	§ 103	Fujimura and Kim

111. The references relied upon by Petitioner and Dr. Schonfeld in his declaration are summarized below:

A. **Kim (EX1004)**

112. U.S. Patent Application Publication No. 2004/0156545 ("Kim") is entitled "Method for Detecting Pattern-Like Images and Method for Enhancing Images While Suppressing Undesirable Artifacts Caused by Pattern-Like Images." Kim was filed on February 7, 2003, published on August 12, 2004, and lists Yeong-Taeg Kim as the inventor. EX1004. Kim is assigned to Samsung Electronics Co., Ltd. *Id.*, cover page.

113. Kim relates to the field of video signal processing and, more specifically, to a method for detecting a "pattern-like image." EX1004 ¶ [0001]. Kim

explains that when enhancing an input image consisting of a pattern-like image, “unnatural and undesirable artifacts arise as a side effect” of performing video enhancement based on the statistics of a given video signal. *Id.* Kim provides examples of applications including contrast enhancement and color enhancement, “which are based on image characteristics and are usually used for normal images (not pattern-like images).” *Id.*

114. Kim’s stated object is to “provide a method for detecting a pattern-like image and a method for suppressing undesired artifacts caused by enhancing an input image with a pattern-like image.” EX1004 ¶ [0002]. To accomplish this, Kim discloses a method that includes obtaining a histogram $h[x]$ of an input image, dividing the histogram into at least a first subset of samples and a second subset of samples, and determining whether the input image is a pattern-like image based on a relationship between the number of samples in each subset. *Id.*, ¶ [0003].

115. In Kim’s preferred embodiment, the histogram of an input picture (field or frame) is computed, and the set of input gradation levels is clustered into two subsets P_1 and P_2 , where P_1 is the set of gradation levels whose histogram values are greater than a predetermined constant K , and P_2 is the set of gradation levels whose histogram values are less than or equal to K . EX1004 ¶¶ [0022]-[0026]. The notion behind this clustering is “to distinguish the gradation levels that have relatively large

histogram values (or a large distribution), since the histogram of a pattern-like signal will have large histogram values at certain gradation levels.” *Id.*, ¶ [0032].

116. Based on the clustering, Kim computes two parameters: n_1 , the total number of samples whose histogram values are greater than K , and n_2 , the total number of samples whose histogram values are less than or equal to K . EX1004 ¶¶ [0033]-[0035]. Kim then defines a pattern-like image detection parameter r using the equation $r = \min(1.0, (n_1/n_2) \cdot (1/A))$, where A is a predetermined constant. *Id.*, ¶¶ [0037]-[0038]. Kim states that “[o]ne can conclude that the input image is most likely a pattern-like image as the value of the pattern-like image detection parameter r approaches 1 and that the input image is most likely a normal image as the value of the pattern-like image detection parameter r approaches 0.” *Id.*, ¶ [0039].

117. Kim discloses an apparatus 20 for detecting a pattern-like image (Figure 3), which includes a histogram calculation device 10, a histogram memory 12, an n_1 and n_2 calculation device 14, and a pattern-like image detection parameter r calculating device 16. EX1004 ¶ [0040], Fig. 3. For the incoming video or image input, a histogram of one frame is determined and stored, and then the calculation devices compute the values of n_1 , n_2 , and r . *Id.*

118. Kim also discloses an image enhancement system (Figure 4) that utilizes the pattern-like image detection parameter r to adaptively adjust the output of the enhancement system. EX1004 ¶ [0041], Fig. 4. The system includes an image

enhancer 32 that always produces an enhanced image e from the input image f , an r calculation device 34, and a mixer 36. *Id.* The adjusted image g is obtained using the equation $g = r \cdot f + (1 - r) \cdot e$, such that when $r = 0$ (a normal image), the output is the fully enhanced image, and when $r = 1$ (a pattern-like image), the output is the original unenhanced input image. *Id.*, ¶¶ [0042]-[0043]. I note that the equation explicitly accounts for values of r between 0 and 1, which would result in g being some combination of both f and e . *Id.* For example, if the value of r were 0.5, then the resulting output g would comprise half of f and half of e . That is, e (the enhanced image) is always calculated, and it can be used in whole (where r is 0), in part (where r is between 0 and 1), or discarded (when r is 1). *See id.*

119. Importantly, Kim is directed to evaluating an *entire* input image (that is, the totality of a frame). Kim's parameter r is assigned to the entire input image as a whole—Kim does not disclose detecting whether any particular *portion* of the image is pattern-like. *See* EX1004 ¶¶ [0039]-[0040], Fig. 5. An example of such a total frame is shown below in Kim FIG. 1.

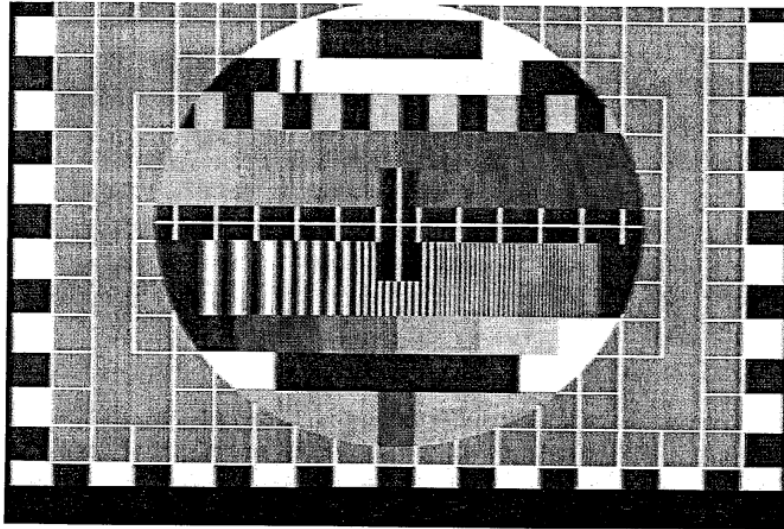


FIG. 1

Id., FIG. 1. Kim refers to “pattern-like image” over eighty times throughout the specification, including in the Title, Abstract, Claims, and Description of the Preferred Embodiments, consistently referring to the entire image rather than any portion thereof. *See generally* EX1004.

B. Fujimura (EX1005)

120. U.S. Patent No. 5,808,697 (“Fujimura”), entitled “Video Contrast Enhancer,” was filed on June 14, 1996, and issued on September 15, 1998. The named inventors are Naohiro Fujimura, Hitoshi Hasegawa, Takuji Kurashita, Hiroshi Onishi, Masayuki Tsuji, Yuuji Yamamoto, and Shinji Takeuchi, all of Tokyo, Japan. The patent is assigned to Mitsubishi Denki Kabushiki Kaisha, also of Tokyo, Japan. EX1005.

121. Fujimura relates to a contrast enhancer for enhancing the luminance contrast and color-saturation contrast of a video signal in a television receiver, video

tape recorder, or other video apparatus. EX1005, 1:5-10. The patent identifies several problems with conventional histogram equalization methods, including over-enhancement, excessive contrast compression at the black and white ends of the luminance scale, undulating distortion in moving images, flicker due to abrupt changes of mapping functions between frames, and unnatural chrominance enhancement. EX1005, 1:10-55.

122. To address these problems, Fujimura discloses multiple embodiments of a contrast enhancer. The first embodiment (Figure 1) includes a luminance contrast enhancer 2 and a chrominance contrast enhancer 4. EX1005, 3:63-4:15. The luminance contrast enhancer 2 comprises a block average processor 6, a mapping function selector 8, a selection memory 10, a primary mapper 12, three secondary mappers 14, 16, and 18, a weighted average processor 20, and a parameter table 22. *Id.* The block average processor 6 divides each image into a plurality of rectangular blocks, calculates a mean luminance level for each block, and these mean luminance levels are used to select mapping functions that enhance contrast in different luminance ranges. EX1005, 4:15-55. The selection signal changes at a limited rate—at minimum intervals of a certain number of consecutive images—to avoid flicker. EX1005, 5:15-45.

123. Fujimura notes that its “luminance contrast enhancer 2” and “chrominance contrast enhancer 4” can “be created from standard building blocks

such as standard cells in an application-specific integrated circuit” and that “[a]lternatively, a general-purpose processor such as a digital signal processor can be provided with the necessary memory and programmed to carry out the functions of some or all of these circuits.” EX1005, 3:63-4:11. Notably, Fujimura is silent regarding how other elements might be implemented. For example, while it describes how the aforementioned enhancers might be implemented (using a “processor” or the like), it is notably silent regarding elements such as the “letterbox signal detector 46” and the “vertical limiter[s]” in FIG. 17. *Id.*, FIG. 17.

124. The second embodiment (Figure 8) simplifies the luminance contrast enhancer by replacing the multiple secondary mappers and weighted average processor with a luminance histogram processor 34 and a maximum count selector 36, which select a single mapping function for the entire image rather than per-block. EX1005, 8:55-9:35. The chrominance contrast enhancer in this embodiment uses a 4fsc sampling circuit 38, an absolute value processor 40, and a one-period average processor 42 to enable linear mapping that preserves hue. EX1005, 9:35-10:60.

125. The third embodiment (Figure 15) replaces the parameter table and separate mappers with a single mapping function memory 45 that stores mapping functions as look-up tables, enabling mapping functions of arbitrary shape for optimum contrast enhancement. EX1005, 12:15-50.

126. Of particular relevance to this proceeding is the fourth embodiment (Figure 17), which adds a letterbox signal detector 46, a first vertical limiter 47, and a second vertical limiter 48 to the luminance and chrominance contrast enhancers of the preceding embodiments. EX1005, 13:30-45. The letterbox signal detector 46 determines whether the luminance signal Y is a letterbox signal—a video signal consisting of a picture area with black non-picture bands above and below, produced when a picture with one aspect ratio is reproduced on a screen with a different (in this example, smaller) aspect ratio (e.g., a 16:9 EDTV signal on a 4:3 screen). EX1005, 13:45-14:5. If a letterbox signal is detected, the letterbox signal detector 46 outputs a pair of line numbers specifying the starting and ending lines of the picture area, and a signal indicating whether a caption is present in the lower non-picture band. EX1005, 13:50-58.

127. Internally, the letterbox signal detector 46 (Figure 19) includes a comparator 50 that classifies pixels as bright or dark by comparing luminance levels against a threshold. EX1005, 14:5-12. A bright-pixel counter 52 counts bright pixels in each horizontal scanning line, and a starting line detector 54 identifies the first line where the bright-pixel count exceeds a second threshold as the starting line of the picture area. EX1005, 14:12-24. A dark-pixel counter 56 then counts dark pixels in subsequent lines, and an ending line detector 58 identifies the first line where the dark-pixel count exceeds a third threshold as the ending line of the picture area.

EX1005, 14:25-40. The vertical limiters 47 and 48 provide letterbox control signals L so that the enhancement (luminance and chrominance contrast enhancers 2 and 4) will only operate on some horizontal scanning lines. EX1005, 14:50-59.

128. The fifth embodiment (Figure 20) extends letterbox detection by using both luminance and chrominance information, adding an adder 64 that sums the chrominance amplitude signal with the luminance signal before supplying the result to the letterbox signal detector. EX1005, 15:5-30. This enables correct identification of scanning lines with low luminance but high color saturation, such as blue sky or blue background areas. *Id.* The sixth embodiment (Figure 21) adds a luminance pre-processing circuit—including a dark-pixel counter 66, a dark-line counter 68, and a black-offset canceler 70—to identify and remove black offset from pre-recorded video cassette signals prior to contrast enhancement. EX1005, 15:40-16:20.

VIII. GROUND 1: PETITIONER AND DR. SCHONFELD FAIL TO ESTABLISH THAT CLAIMS 1-4 WOULD HAVE BEEN OBVIOUS BASED ON KIM

129. It is my opinion that Petitioner and Dr. Schonfeld fail to establish that claims 1-4 would have been obvious based on Kim.

A. Claim 1

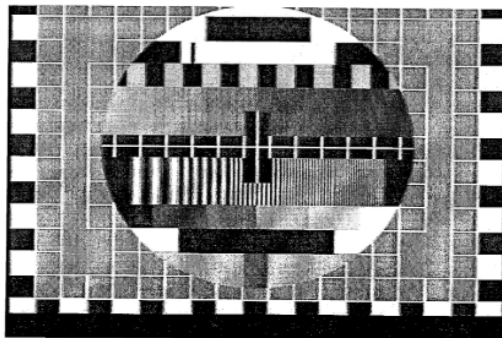
1. Limitation [1.b]

130. It is my opinion that Kim fails to disclose or render obvious limitation [1.b]: “a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit.” That is because a POSITA

would recognize that Kim's pattern occupies an entire frame without "*contents*" and thus does not actually detect "*whether pattern portions other than contents are contained in the video signal input to the video unit.*"

131. In my review of Dr. Schonfeld's declaration, it appears that he argues that two different elements of Kim are the "*detector*": both (1) the "*r* calculation device 34" and (2) the "apparatus 20." I note that the "*r* calculation device" is actually part of the "apparatus 20" (EX1004 FIG. 3), meaning that this distinction is minimal at best. All the same, I address the two approaches separately below.

132. It is my opinion that Kim's "*r* calculation device 34" does not detect "*whether pattern portions other than contents are contained in the video signal input to the input unit.*" As I discuss in my introduction to Kim above, Kim's frames are themselves patterns, meaning that there are no "*contents*" in the frame. For example, Figure 1 of Kim, reproduced below, shows a frame that exclusively comprises a pattern:



EX1004 Fig. 1. In this frame, there are no “*contents*” other than the “*pattern portions*” themselves. *See Id.* Kim’s focus is identifying these pattern frames (that is, identifying that the frame itself is just a pattern) and not correcting them. *Id.*, FIG. 5. Kim is clear on this point: for example, FIG. 5 shows correction of “an input image,” which a POSITA would readily recognize refers to an entire frame:

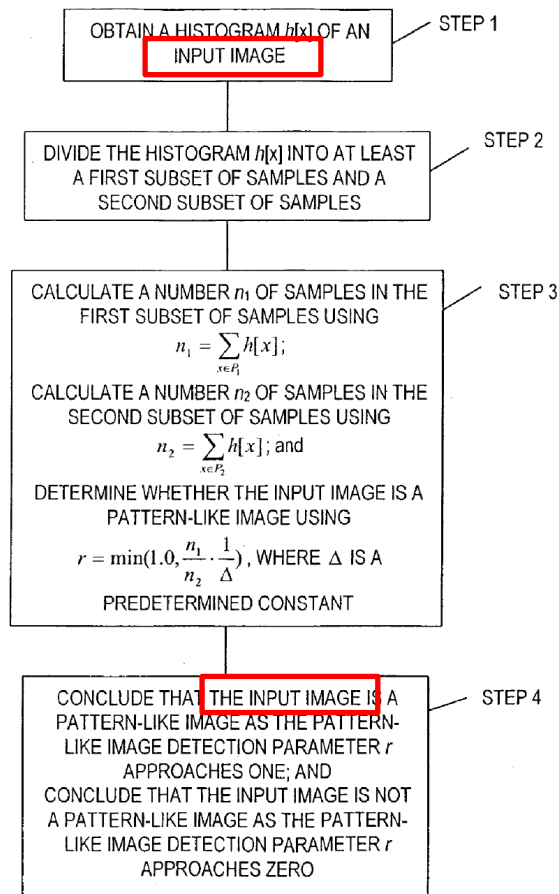


FIG. 5

Id., FIG. 5. In other words, a POSITA would recognize that Kim has no need for a “detector which detects whether pattern portions other than contents are contained

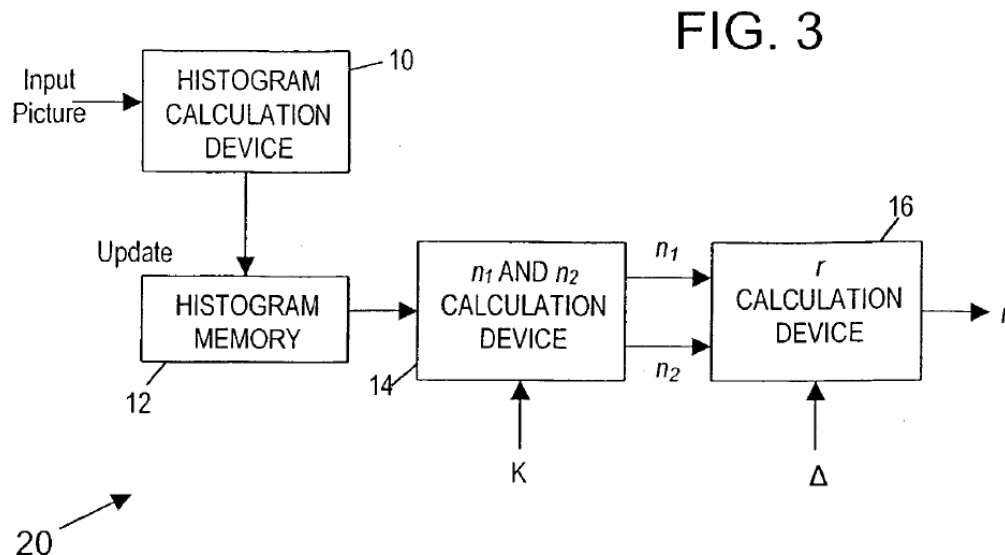
*in the video signal input to the input unit” because the exclusive question is whether the frame is a pattern, not the question of whether a frame with “*contents*” also contains “*pattern portions*.”*

133. Kim’s calculation of r also underscores why a POSITA would not use it to determine “*whether pattern portions other than contents are contained in the video signal input to the input unit.*” In Kim, the value of r (which is a value from 0 to 1, including intermediary values) is used to determine how likely the entire input frame is directed to a pattern-like image and does not contemplate that some portion of the frame might be a pattern and some other portion of the frame might not be a pattern. EX 1004 ¶ [0039]. The focus is always the totality of the frame, and the correction is based on how likely that entire frame is a pattern-like image.

134. In fact, a POSITA would not be able to use any portion of Kim to distinguish “*pattern portions*” from “*contents*” in a frame. There is not a single part of Kim that discusses a “*portion[]*” of a frame, nor are any other similar terms (*e.g.*, “part,” “segment,” “section”) that indicate handling of a subset of a frame. *See, e.g.*, EX1004 ¶ [0040]. To the contrary, Kim is exclusively focused on the “input image”; that is, a total frame. To that end, Kim is focused on determining whether the totality of the image is a “pattern-like image,” to the point where it uses the term “pattern-like image” over eighty times in its specification, including in the Title, Abstract, Claims, Background of the Invention, Filed of the Invention, Summary of the

Invention, Brief Description of the Drawings, and Description of the Preferred Embodiments sections. *See generally* EX1004. A POSITA would not be able to use Kim to know how to distinguish “*contents*” of a frame (the “*image*”) from “*pattern portions*” of the frame, as this nuance is simply not contemplated by Kim in any way.

135. Kim’s “apparatus 20” has the same deficiencies as its r calculation device: a POSITA would readily recognize that the apparatus does not detect “*whether pattern portions other than contents are contained in the video signal input to the input unit.*” After all, FIG. 3 indicates that the apparatus 20 includes the “ r calculation device 16” as well as other elements, such as a histogram calculation device:



EX1004 Fig. 3. None of the above additional elements (e.g., the histogram calculation device, the histogram memory, the n_1 and n_2 calculation device) change my conclusions above.

136. Dr. Schonfeld also argues that, to the extent this limitation is construed as a means-plus-function limitation with a corresponding structure of a CPU and its equivalents, Kim discloses that the functions of r calculation device 34 are performed in a CPU or equivalent, or it would have been obvious. EX1003 ¶ 70. Based on my review of the Petition and Dr. Schonfeld's declaration, I am not aware of any proposed claim construction for the "*detector*" in the first place. All the same, and assuming that the relevant language is construed as having a structure of a CPU and/or its equivalents, Kim does not describe any such CPU or equivalents: Kim is utterly silent as to the concept of a CPU, much less any other equivalent elements. See EX1004. And, even if Kim did disclose a CPU or the like, Kim still does not describe the claimed "*detector*." While the " r calculation device" might involve some form of arithmetic processing, a POSITA would recognize that the " r calculation device" (and/or the "apparatus 20") still do not act as "*a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit.*" That is, the " r calculation device" and/or the "apparatus 20" do not teach this feature whether or not they are embodied in a CPU or an equivalent to a CPU. They do not perform the relevant step of detecting

“whether pattern portions other than contents are contained in the video signal input to the input unit.” After all, in Kim, the relevant frame(s) do not have “*contents*” in the first place: there is no scenario where a frame containing “*contents*” also contains “*pattern portions other than contents.*”

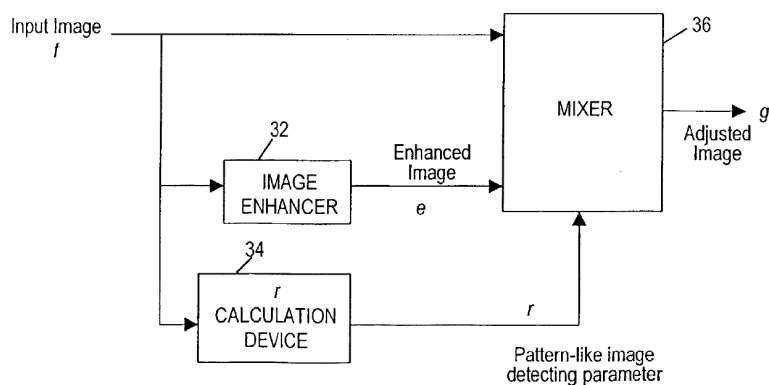
137. For at least the foregoing reasons, Petitioner and Dr. Schonfeld fail to show a reasonable likelihood of success in establishing that claim limitation [1.b] would have been rendered obvious based on Kim.

2. Limitation [1.c]

138. Claim limitation [1.c] recites “*a corrector which corrects the video signal input to the input unit.*” In my opinion, Petitioner and Dr. Schonfeld fail to establish limitation [1.c] would be rendered obvious in view of Kim. EX1003 ¶¶ 71-74. That is at least because, even using Petitioner and Dr. Schonfeld’s construction of “*corrector,*” there is no such “*corrector*” in Kim.

139. Petitioner and Dr. Schonfeld argues that Kim’s “[i]mage enhancer 32 and mixer 36” are “*a corrector.*” EX1003 ¶ 71. Petitioner and Dr. Schonfeld also argues that, to the extent that this limitation is a means-plus-function limitation in which the proposed structure is a “CPU 7 or equivalents thereof,” Kim’s “[i]mage enhancer 32 and mixer 36” are a CPU (or equivalent) that “*corrects the video signal input to the input unit.*” EX1003 ¶ 74.

140. I disagree: even assuming that this limitation is a means-plus-function limitation required to have the structure of a CPU or its equivalents, a POSITA would readily recognize that both the “image enhancer 32” and the “mixer 36” of Kim need not be performed by a CPU or an equivalent. Image enhancement might be performed by a CPU, but image enhancement might equally be performed a variety of other ways. For example, around the time of the ’645 Patent (and Kim), analog video signals were extremely common, meaning that various forms of analog non-CPU enhancement (*e.g.*, filtering, modification of voltages) could be performed by the “image enhancer 32.” Similarly, with respect to the “mixer 36,” the mixing of different video signals (analog or digital) based on some singular input value (such as r) could have been performed using analog circuitry. And, either element could readily be constructed using some subset of transistors that, while operating via some form of logic, are not equivalent to a “CPU” in the sense that such transistors would simply operate in a limited (albeit logical) manner without any form of processing. Kim does not provide any specific guidance in this respect, as it is utterly silent as to CPUs at all. Consider, for example, FIG. 1 of Kim:



No portion of this figure indicates that either the “image enhancer 32” and/or the “mixer 36” are a CPU or equivalent. In fact, it seems to suggest the opposite: the “*r* calculation device” is described as a “device,” whereas the other elements are not described as a “device.”

141. Petitioner provides a variety of arguments in support of the idea that, to the extent that these limitations are means-plus-function limitations, Kim’s “image enhancer 32” and/or “mixer 36” would be understood by a POSITA to be implemented using a CPU or equivalents, and I disagree with all of these arguments.

142. First, Petitioner argues that a POSITA would have understood that the disclosed functionality is performed by executing instructions in such a CPU “because without such a component, there would be no apparatus to implement the disclosed functionality.” Pet. 26. Not so. As I note above, one could easily implement image enhancement and/or mixing using (among other things) analog circuits that are not always analogous to a CPU or its equivalents.

143. Second, Petitioner argues that “Kim inherently (necessarily) discloses such a CPU or equivalent for the same reasons.” Pet. 26. Again, this is not accurate. Kim is silent as to a CPU or its equivalents, and nothing in Kim would lead a POSITA to conclude that these elements must necessarily be implemented using a CPU or its equivalents. Rather, Kim is silent on the entire topic, which would lead a POSITA to conclude that these elements could be implemented in a variety of ways.

144. Finally, Petitioner asserts that “it would have been obvious to a POSITA to implement the functionality of Figure 4 in a CPU or equivalent as a well-known way of implementing such functionality.” Pet. 26. While CPUs can be used for a variety of tasks, it is far from the case that a POSITA would be necessarily led to the conclusion that correction must be performed with a CPU. After all, a variety of considerations (cost, a desire to avoid complexity, ease of implementation) might lead a POSITA to implement image correction, Kim’s “image enhancer 32” and/or Kim’s “mixer 36” using analog circuitry. For example, Kim was filed back in 2003, when NTSC analog video and Cathode Ray Tube (“CRT”) televisions were quite common, and it would not be unreasonable to anticipate that an element like the “mixer 36” would be implemented using analog circuitry to avoid the excess cost of using a CPU and in view of the analog circuitry already present in televisions. And, particularly at the time the ’645 Patent (and, for that matter, Kim) was filed, video processing using CPUs was computationally complicated and expensive: a POSITA

would have many reasons (cost, simplicity) to explore ways to enhance video without necessarily involving a CPU or its equivalents.

145. In sum, Kim does not disclose a CPU or its equivalents, Kim does not suggest that its “image enhancer 32” and/or “mixer 36” would need to be implemented using a CPU or its equivalents, and neither Petitioner nor Dr. Schonfeld provide any evidence supporting the contention that implementing the functionality in a CPU or an equivalent to a CPU would be obvious without such disclosure.

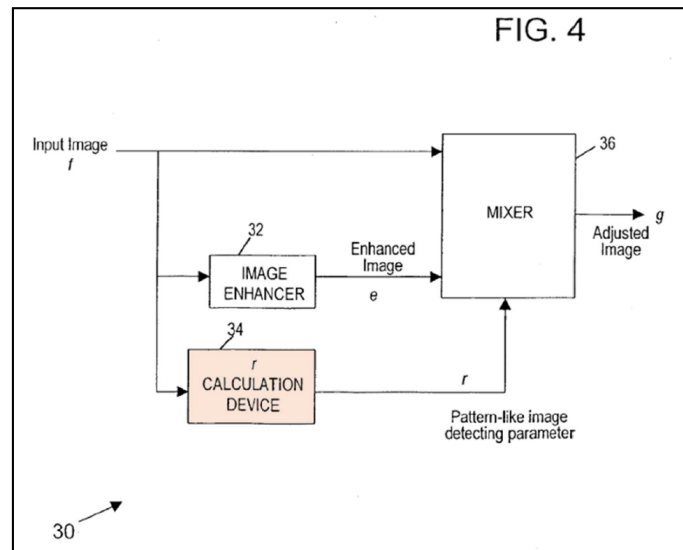
3. Limitation [1.d]

146. Claim limitation [1.d] recites “*a controller which controls the corrector to cause the corrector to correct the video signal input to the input unit when the pattern portions are not contained, and which controls the corrector to cause the corrector not to correct the video signal when the pattern portions are contained.*”

In my opinion, both Petitioner and Dr. Schonfeld fail to establish that claim limitation [1.d] would be rendered obvious in view of Kim. EX1003 ¶¶ 75-77. This is for two reasons. First, a POSITA would recognize that Kim’s “*r* calculation device 34” fails to “*control[]*” anything. Second, Petitioner has failed to show that Kim’s calculation device is a “*controller*” even under the broadest construction of that term.

147. It is my opinion that a POSITA would not interpret Kim’s “*r* calculation device 34” as “*control[ling]*” anything. As shown in Kim Figure 4, Kim’s “image

enhancer 32” always enhances the “input image f ” to generate the “Enhanced Image e ,” and the “ r calculation device 34” merely outputs a parameter r used by the “mixer 36” to selectively include or not include the “Enhanced Image e ” as part of the “Adjusted image g ”:



EX1001, FIG. 4. That is, as I noted in my summary regarding Kim, Kim always generates the “Enhanced Image e ” and, because r might be a variety of values between 0 and 1, all, portions, or none of that enhanced image might be later used to generate the “Adjusted Image g .” EX1004 ¶ [0042]. Nothing controls the “image enhancer 32,” it is depicted and described in Kim as receiving the input image and outputting the enhanced image without further instruction. It is merely the decision as to how much of that enhanced image to use that is controlled by the value of r output by the “ r calculation device 34.” There is no pathway shown between the “ r calculation device 34” and the “image enhancer 32,” meaning that there is no

modality with which the former could control the latter. In turn, there is thus no point where the “*r* calculation device 34” “*controls the corrector to cause the corrector not to correct the video signal when the pattern portions are contained.*”

148. In turn, I disagree with Petitioner and Dr. Schonfeld: Kim’s *r* calculation device 34 is not “*a controller.*” See EX1003 ¶ 76 (Dr. Schonfeld argues that the “[c]alculation device 34 therefore is the recited *controller* that *controls* mixer 36.”) The “*r* calculation device 34” outputs a value, *r*, that determines how much of an already-calculated enhanced image is used later. It provides a value that has to be processed (using another equation) to determine what to do. The output of such a parameter does not “control” the mixer (or, for that matter, the “image enhancer 32”). In the same sense, I might use a thermometer to decide whether to wear a coat outside, but the thermometer does not control me: rather, the thermometer is one value that I use to decide independently whether I want to wear a coat.

149. I also note that Petitioner and Dr. Schonfeld’s argument that the “*r* calculation device 34” is a “*controller*” fails because they have failed to show that, to the extent that this language is subject to means-plus-function treatment, the “*controller*” is a CPU or an equivalent. A controller generally comprises some sort of processing circuitry, such as a central processing unit (“CPU”). See, e.g., EX2016, 3 (“[m]icrocontrollers combine the fundamental resources available in a microcomputer such as the CPU, memory, and I/O resources in a single chip”). The

'645 Patent uses this approach when discussing its own "*controller*": it describes that a CPU causes correction of the video signal input based on when the pattern portions are contained:

FIG. 34 shows a processing flow in the CPU 7. Correction characteristics update processing in the CPU 7 is executed by receiving the interrupt 141 from the I/F unit 155. When the pattern flag is "0" at S3401, i.e., when there is no pattern portion, the CPU 7 calculates correction data to conduct the picture quality enhancement processing by using the method described in the first embodiment or the second embodiment at S3402, and transmits the correction data to the I/F unit 153 (S3404). When the pattern flag is "1" at S3401, i.e., when there is a pattern portion, the CPU 7 sets correction data="0" at S3403, and transmits the correction data to the I/F unit 153 (S3404).

EX1001, 18:50-61. But, as I've already discussed above, both Petitioner and Dr. Schonfeld fail to show that Kim describes such a "*controller*," let alone a CPU, equivalents of a CPU, or the like. Instead, Petitioner and Dr. Schonfeld simply seem to assume that the *r* calculation device is a CPU or an equivalent simply because it performs calculations. That's not the case: various electronically implemented functions may be represented as equations without necessarily requiring a CPU or an equivalent of a CPU. For example, since *r* is calculated using a minimum and two values (n_1 and n_2), it would not be unreasonable to assume that these values might be calculated using a simple set of hardwired transistors and/or logic gates that would not comprise a CPU or an equivalent. And, again, a POSITA would be motivated to explore more simplistic (*e.g.*, analog) approaches to such processes. After all, while it might be tempting to assume with the benefit of modern technology that CPUs can

essentially be deployed in any environment, at the time of Kim (and, for that matter, the '645 Patent), cost, availability, reliability, and simplicity considerations would have meant that a POSITA would not always turn to CPUs or their equivalents to perform steps like this, especially when other more rudimentary circuitry could be used instead.

150. Put simply, it is my opinion that Petitioner and Dr. Schonfeld fail to address how a calculation device satisfies the controller aspect recited in limitation [1.d] and thus fails to show how limitation [1.d] is rendered obvious by Kim. In view of the foregoing, it is my opinion that they thus fail to establish that claim limitation [1.d] would be rendered obvious in view of Kim. EX1003 ¶¶ 75-77.

B. Claim 2

151. Claim 2 depends from claim 1. Therefore, for at least the reasons provided above in relation to claim 1 in Ground 1, it is my opinion that Petitioner and Dr. Schonfeld fail to establish that claim 2 would have been rendered obvious based on Kim.

1. Limitation [2.b]

152. Claim limitation [2.b] recites “*wherein the corrector corrects the video signal according to the level or distribution detected by the characteristic point detector.*” Petitioner and Dr. Schonfeld’s arguments regarding this limitation fail because they misunderstand and blend completely different portions of Kim. As

such, it is my view that a POSITA would not have found claim limitation [2.b] obvious in view of Kim.

153. The Petition seems to take the position that “mixer 36 corrects image f of the incoming video based in part on parameter r ” and that the parameter r “is calculated from the luminance histogram using equations (1) through (5),” with mixer 36 (alleged by the Petition to be the “*corrector*”) therefore “correct[ing] the video signal according to the luminance histogram.” Pet. 31. But the Petition already argued that the calculation of r and the mixer 36 are the “*controller*.” In other words, if those elements are already the “*controller*,” then they cannot simultaneously in a dependent claim “*correct[] the video signal according to the level or distribution detected by the characteristic point detector.*” At that point, the characteristic point detector becomes superfluous, or at least indeterminate. Combining the two elements would not have been obvious to a POSITA as they perform very different functions and are explicitly different in the claims.

A. Claim 3

1. Limitation [3.b]

154. In relation to limitation [3.b], Petitioner and Dr. Schonfeld merely cite back to limitation [1.b]. EX1003 ¶ 88 (“Kim discloses this limitation. *See* limitation 1.b.”). Therefore, for the reasons provided above in relation to limitation [1.b], it is

my opinion that Petitioner and Dr. Schonfeld fail to establish that claim limitation [3.b] would have been rendered obvious in view of Kim.

2. Limitation [3.e]

155. In relation to limitation [3.e], Petitioner and Dr. Schonfeld rely on similar rationale as in limitation [1.d]. EX1003 ¶ 91 (“As described for limitation 1.d, calculation device 34 is a controller that controls mixer 36.”). As provided above in relation to limitation [1.d], it is my opinion that Petitioner and Dr. Schonfeld provide no analysis for how the “*r* calculation device” satisfies the “*controller*” or “*control*” aspects of the limitation. *See id.; supra* Section VI.A.1.c. Therefore, in my opinion, Petitioner and Dr. Schonfeld fail to establish that claim limitation [3.e] would have been rendered obvious in view of Kim.

B. Claim 4

156. Claim 4 depends from claim 1. Therefore, for at least the reasons provided above, in my opinion, Petitioner and Dr. Schonfeld fail to establish that claim 4 would have been rendered obvious based on Kim.

IX. GROUND 2: PETITIONER AND DR. SCHONFELD FAIL TO ESTABLISH THAT CLAIMS 1-4 WOULD HAVE BEEN OBVIOUS BASED ON FUJIMURA

157. It is my opinion that Petitioner and Dr. Schonfeld fail to establish that claims 1-4 would have been obvious based on Fujimura.

A. Claim 1

1. Limitations [1.a] and [1.b]

158. Claim limitation [1.a] recites “*an input unit to which a video signal containing contents is input.*” Claim limitation [1.b] recites “*a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit.*” It is my opinion that neither are obvious in view of Fujimura, despite the Petitioner and Dr. Schonfeld’s assertions to the contrary. Pet. 36-42.

159. As I have explained in detail above, a POSITA would recognize that “*video signal*” is “a frame or series of related frames, such as a scene,” and Fujimura does not in any way teach this concept. Petitioner and Dr. Schoenfeld might aver to the concept of frames of video, but their analysis is in fact keyed on horizontal scanning lines of video. Pet. 36-37. While video might have horizontal scanning lines, the claims are clear that they relate to frames or series of related frames, and whether a frame with “*contents*” also contains “*pattern portions.*” Since Fujimura’s technique is based on an observation that it can step through individual horizontal scanning lines to find all-black lines and determine they represent letterbox boundaries, Fujimura itself indicates that a scan line (allegedly the “*video signal*”) would be exclusively “*pattern portions*” or “*contents,*” not both. A POSITA would thereby realize that treatment of individual scanning lines as the claimed video signal is inconsistent with the claims and disclosure in the ’645 Patent.

2. Limitation [1.d]

160. Claim limitation [1.d] recites “*a controller which controls the corrector to cause the corrector to correct the video signal input to the input unit when the pattern portions are not contained, and which controls the corrector to cause the corrector not to correct the video signal when the pattern portions are contained.*”

In my opinion, both Petitioner and Dr. Schonfeld fail to establish that claim limitation [1.d] would be rendered obvious in view of Fujimura. EX1003 ¶¶ 108-111. This is for at least three reasons. First, Petitioner has failed to consistently identify a “*video signal*,” leading its interpretation of this step to be impermissibly vague. Second, Fujimura’s “vertical limiter” is not a “*controller*,” particularly if that element must be implemented by structure such as a CPU or its equivalents. Third, Fujimura’s alleged controller (the “vertical limiter”) does not “*cause the corrector not to correct the video signal when the pattern portions are contained.*” I address these three reasons in turn below.

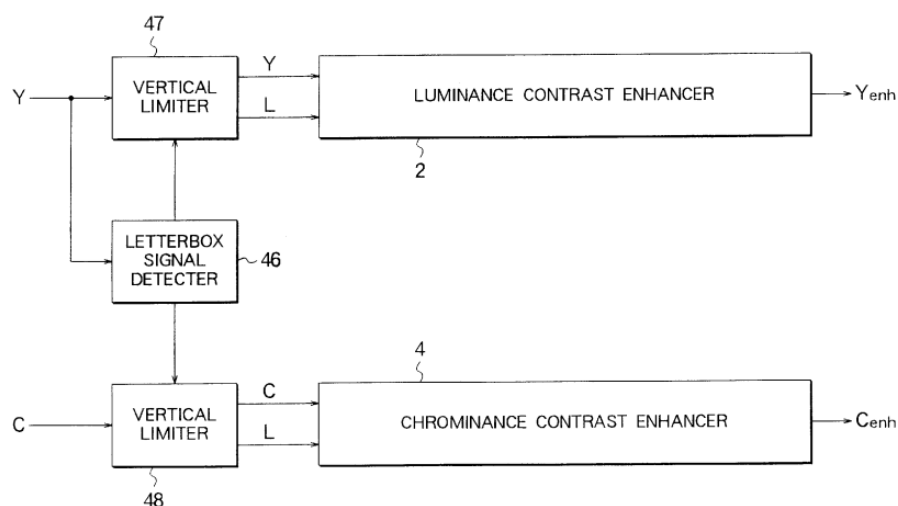
161. First, I note that Petitioner’s approach to this feature underscores the unreasonableness of treating the “*video signal*” as a horizontal scanning line. The Petition repeatedly emphasizes that the “*video signal*” are Fujimura’s horizontal scanning lines. *See, e.g.*, Pet. 45. But there is never a point with which the “*video signal*” (allegedly a horizontal scanning line) contains both “*pattern portions*” and “*contents.*” That is, Fujimura never considers whether a horizontal scanning line that

already contains “*contents*” also contains “*pattern portions*.” As I noted above, Fujimura suggests the opposite: that the horizontal scanning line might be substantially black (and thus part of letterboxing), or it contains video content. Not both.

162. Second, I disagree with Petitioner and Dr. Schonfeld: the “vertical limiter 47” is not “*a controller*” to the extent that the required structure for “*a controller*” comprises a CPU or its equivalents. Petitioner fails to show that the “vertical limiter 47” is such a CPU or an equivalent of a CPU. While Fujimura does describe that certain elements may be “created from standard building blocks” including a “general-purpose processor” and/or “a digital signal processor,” this section does not include the “vertical limiter 47.” See EX1005, 3:63-4:11. To the contrary, that section only discusses elements the “luminance contrast enhancer” and the “chrominance contrast enhancer” and portions of those enhancers. *Id.* In fact, Fujimura is totally silent as to what, if anything, the “vertical limiter 47” is, suggesting that it could be a variety of things—it could be some form of analog circuitry, for example. A POSITA would readily find it desirable to implement a vertical limiter using simple electronic circuitry and/or analog hardware, as doing so would be far cheaper and simpler than trying to do so via a CPU. And, based on my review, neither Petitioner nor Dr. Schonfeld purport to identify what circuitry the “vertical limiter 47” has, or why it is alleged to be the claimed “*controller*” in the

first place. This adds quite a bit of ambiguity because, as I discussed before with respect to Kim, a variety of systems made at the time of Fujimura (and the '645 Patent) might have avoided using CPUs and might have instead used simple analog circuitry for cost considerations, for reliability, or the like.

163. Third, it is my opinion that neither Petitioner nor Dr. Schonfeld show that Fujimura “controls the corrector to cause the corrector not to correct the video signal when the pattern portions are contained.” Fujimura’s “vertical limiter 47” (one of two: there is also a “vertical limiter 48”) receives information from a “letterbox signal detector 46” including “line numbers” for the “non-picture band.” EX1005, 13:34-58. The two vertical limiters then operate to “provide the luminance signal Y and chrominance signal C to the luminance and chrominance contrast enhancers 2 and 4, together with letterbox control signals L.” *Id.*, 13:60-63. This is depicted in FIG. 17 of Fujimura:



EX1005, FIG. 17. Based on my review, I understand that Petitioner and Dr. Schonfeld argue that this feature is taught insofar as Fujimura selectively enhances horizontal scanning lines based on whether or not they are part of a letterbox section. Pet. 66-67. But horizontal scan line-level correction is not what the claim requires: it satisfy the requirement of “*control[ling] the corrector to cause the corrector not to correct the video signal when the pattern portions are contained.*” The relevant portion of the claim involves not correcting “*the video signal*”—that is, not applying relevant corrections (*e.g.*, in the context of Fujimura, chrominance or luminance correction) to the entire frame. Fujimura does apply those corrections to the frame, but that does not mean that the corrections are applied across the totality of the frame. The fact that Fujimura incidentally skips certain lines does not somehow mean it “*controls the corrector to cause the corrector not to correct the video signal when the pattern portions are contained.*” After all, in this process, the power savings benefits of the ’645 Patent are utterly defeated: correction is still performed to the whole frame, with the only caveat that only certain horizontal lines are corrected.

164. In my view, both Petitioner and Dr. Schonfeld fail to address how a vertical limiter satisfies the controller aspect recited in limitation [1.d] and thus fail to show how limitation [1.d] is rendered obvious by Fujimura.

B. Claim 2

165. Claim 2 depends from claim 1. Therefore, for at least the reasons provided above in relation to claim 1 in Ground 2, in my opinion, Petitioner and Dr. Schonfeld fail to establish that claim 2 would have been rendered obvious based on Fujimura.

1. Limitation [2.b]

166. As I noted with respect to Ground 1, it is my opinion that Petitioner and Dr. Schonfeld fail to demonstrate that claim element [2.b] would have been obvious, as their treatment of this feature removes all meaning from the claim language to the point of rendering it superfluous.

167. The Petition asserts that this feature is met by letterbox signal detector 46 operating to detect a starting line of the picture area. Pet. 50-51. Since that correction is performed based on where the line(s) are in a picture area, the Petition claims that this step teaches [2.b]. But I note that the Petition already used the letterbox signal detector's detection of the letterbox boundaries as the claimed controller which controls the corrector to cause the corrector to correct or not correct the video signal based on whether the pattern portion is contained. Pet. 40-42. In turn, like in Ground 1, Petitioner and Dr. Schonfeld are double-dipping, arguing that the same elements perform completely different features. After all, Petitioner and Dr. Schonfeld have already used the output of letterbox signal detector to meet the

claim feature of controlling the corrector to correct or not correct. Allowing this same decision from the alleged pattern detector to also serve as the subsequent, and separate, recitation that the correction itself is carried out based on the visual characteristics detected by the characteristic point detector renders the construction confusing. A POSITA would recognize that these are different elements that warrant separate treatment.

C. Claim 3

1. Limitation [3.b]

168. In relation to this limitation, Petitioner and Dr. Schonfeld merely cite back to limitation [1.b]. EX1003 ¶ 122 (“Fujimura discloses this claim element. *See* element 1.b.”). Therefore, for the reasons provided above in relation to limitation [1.b], in my opinion, Petitioner and Dr. Schonfeld fail to establish that claim limitation [3.b] would have been rendered obvious in view of Fujimura.

2. Limitation [3.e]

169. Claim limitation [3.e] recites “*a controller which controls the corrector to cause the corrector not to change the correction characteristics in the corrector when the pattern portions are contained.*” In my view, Petitioner and Dr. Schonfeld fail to establish that claim limitation [3.e] would be rendered obvious in view of Fujimura for at least the same reasons provided above regarding claim 1. EX1003 ¶¶ 131-132. That is, the same considerations apply: the “vertical limiter” is not a “controller,” and does not “*cause the corrector not to change the correction*

characteristics in the corrector when the pattern portions are contained.” In fact, a POSITA would recognize the opposite: Fujimura’s vertical limiter 47 is line-by-line, not frame-by-frame, meaning that it does “*change the correction characteristics in the corrector*” (on a line-by-line basis) when “*pattern portions are contained*” in a frame.

D. Claim 4

170. Claim 4 depends from claim 1. Therefore, for at least the reasons provided above, in my opinion, Petitioner and Dr. Schonfeld fail to establish that claim 4 would have been rendered obvious based on Fujimura.

X. GROUND 3: PETITIONER AND DR. SCHONFELD FAIL TO ESTABLISH THAT CLAIMS 5-8 WOULD HAVE BEEN OBVIOUS BASED ON FUJIMURA AND KIM

171. It is my opinion that Petitioner and Dr. Schonfeld fail to establish that claims 5-8 would have been obvious based on a combination of Fujimura and Kim.

A. The Proposed Combination of Fujimura and Kim Would Not Be Obvious and Would Result in Numerous Issues

172. Petitioner and Dr. Schonfeld purport to modify Fujimura by adding Kim in order to allegedly correct deficiencies in Fujimura (although, on my review, it’s not clear what those deficiencies are, nor why Kim would be necessary to fix them). Regardless, as I will detail below, the proposed combination is fundamentally flawed. Virtually every single use case combining Fujimura and Kim introduces a bevy of problems (redundant enhancement leading to over-processing, processing

alleged pattern portions, wasteful computation leading to wasted power) that would lead a POSITA away from combining the two references.

173. To illustrate why the Fujimura and Kim combination makes little sense, I have provided two illustrative ways that a POSITA might combine the two references. These are merely two simplified examples for discussion: there are a wide variety of ways to combine the references, and neither Petitioner nor Dr. Schonfeld provide details on how they propose that the two references be combined. Each combination introduces more problems than it solves (although, as I note above, it does not appear that Petitioner has even identified what deficiency Kim helps Fujimura address in the first place). For example, in many circumstances, either of my illustrative combinations of Fujimura and Kim would result in redundant processing of video signals, which would waste power and almost certainly over-process an image to the detriment of its image quality. A POSITA would have easily identified these issues, meaning that a POSITA would not find it obvious or remotely easy to combine the two references. In fact, as I detail below, combining the two references would be extremely difficult because it would almost certainly require reconfiguration of both the Fujimura system and the Kim system in order to make them interoperable without wastefulness, redundancy, or the like.

174. As an aside, I have considered more possible combinations than the two I address below, recognizing that there might be a variety of ways to combine

Fujimura and Kim. That said, since Petitioner and Dr. Schonfeld have not provided even a hint as to how they propose the combination to be effectuated, I am essentially forced to focus on the two illustrative ways I think the references could be combined. There may be a wide variety of ways to combine Kim and Fujimura in the context of different technical environments; however, each of those ways might also present additional hurdles that would push a POSITA away from the proposed combination. For example, there may be possible ways to improve the efficiency of the combined system by somehow modifying Kim to handle horizontal lines so that certain elements of Fujimura could be re-used, but (1) Petitioner does not assert such a combination, and (2) doing so would require a significant reconfiguration of Kim that would be a Herculean task for a POSITA.

1. Example 1: Fujimura Output to Kim Input

175. As I have already discussed above, Fujimura teaches identifying boundaries to restrict correction in a single frame, whereas Kim teaches assigning a value to an entire frame to determine to what degree to apply image enhancement. Note in particular that Fujimura operates in a manner that outputs the starting and ending lines of a picture portion when a video signal is a letterbox signal. *See* EX1005, 13:50-58. In that manner, Fujimura thereby enables restriction of contrast enhance operations “to the area between the starting and ending lines of the picture area.” *See Id.*, 14:50-59. In contrast, Kim assigns a value, r , to an entire input image

on how likely the entire input image is a “pattern-like image” or a “normal image” and then uses that value to selectively mix some, all, or none of an already-generated enhanced image. *See, e.g.*, EX1004 ¶ [0039] (“One can conclude that the input image is most likely a pattern-like image as the value of the pattern-like image detection parameter r approaches 1 and that the input image is most likely a normal image as the value of the pattern-like image detection parameter r approaches 0.”).

176. Implementing Fujimura (with a portion of a video signal modified based on the output line numbers) before Kim (which would look for whole-frame pattern-like images) would have numerous flaws.

177. Say, for example, that Fujimura (implemented first) received a letterboxed signal. If that letterboxed signal were fed into Fujimura, then it could detect the letterboxing, correct the non-letterboxed portion, and then output the correct signal as input into Kim. That is, Kim would receive video content that was already processed, at least in part. It is then highly unclear how Kim would operate. If fed the entire video signal, then Kim would potentially re-enhance the already-enhanced video content, calculate r to determine whether the total frame was a pattern (in this case, extremely unlikely), and then output the enhanced image using the “mixer 36.” *Id.* The combined process would thereby result in a redundant enhancement step, wasting power in direct contravention of the concerns of the ’645 Patent. Moreover, it is also possible that imprecision with respect to the calculation

of r could result in portion(s) of the “Enhanced Image e ” being included as part of the “Adjusted Image,” meaning that the output might be over-corrected. *Id.* Alternatively, if Kim were only fed the non-letterboxed part of the signal of Fujimura (which would require additional processing, as Kim is not focused on horizontal scanning lines), Kim would try to identify whether the remaining portion is a pattern although portions of the frame content would have already been removed. Either approach would be highly undesirable to a POSITA at least insofar as it would include wasteful processing (and thus waste battery power in contravention of the ’645 Patent) and because it would result in an unpredictable system that would (at best) render the functionality of Kim. *Id.*

178. Assume instead that a whole-frame pattern, like that described in Kim, were first fed to the input of Fujimura. For reference, Kim Figure 1 is reproduced below for the purposes of this discussion.

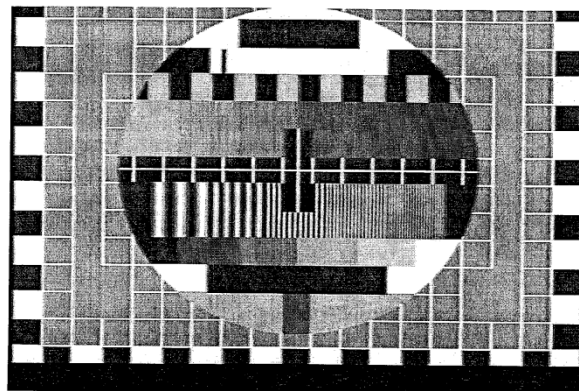


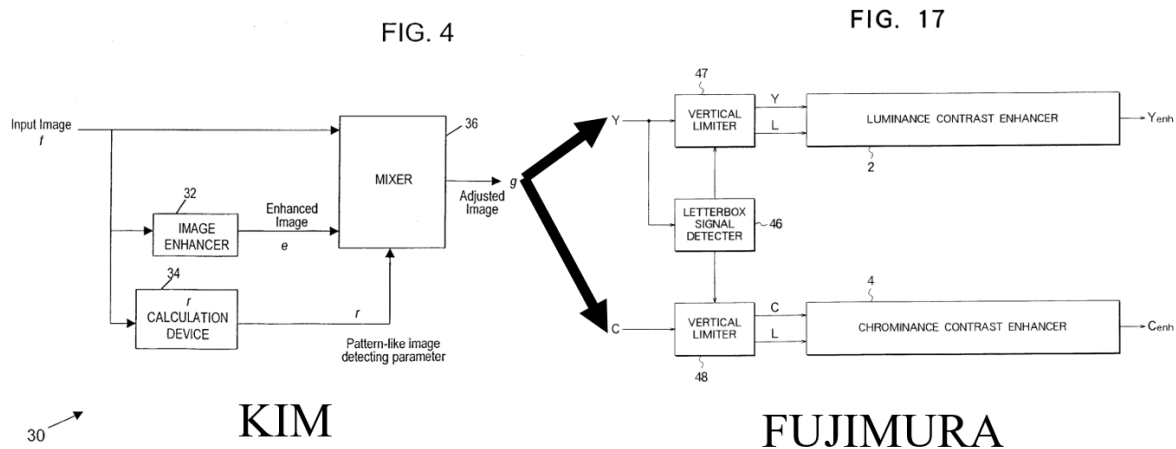
FIG. 1

EX1004, FIG. 1. In this circumstance, the whole-frame pattern includes a substantially black portion at the bottom, which Fujimura may readily mistake as

part of letterboxing. In turn, Fujimura would almost certainly identify this black portion as letterboxing and perform corrections above the black bar. This would potentially result in Fujimura performing corrections on the pattern above that black bar, which is directly contradictory to Kim's approach of avoiding the correction of such patterns. And, of course, it might make it harder for Kim to identify the pattern, whether or not the whole frame or a subpart thereof was provided to Kim.

2. Example 2: Kim Input to Fujimura Output

179. Reversing the ordering of the references, where Kim would be first such that Kim's output would feed into Fujimura's input, would present a variety of problems as well. In this implementation, the "Adjusted Image g" of Kim would be fed, likely line-by-line, to Fujimura:



180. Assume, for example, that letterboxed input was provided as input to Kim—that is, assume letterboxed content was fed into this system as “Input image f.” In this circumstance, to any extent that the frame(s) were even remotely still or

similar, Kim would likely use at least a portion of the “Enhanced image e” to generate the “Adjusted image g,” meaning that at least a portion of the letterboxing portion of the video would be corrected and output as “Adjusted Image g.” Then, Fujimura might have difficulty operating: if the processing of Kim changed the luminance of the letterboxed portions (*e.g.*, by brightening them from black to some gray tone or the like), then Fujimura might fail to identify the letterboxing at all. And, I note that, even if such letterboxing were identified, it is very likely that the content portions of the video would be double-corrected: once by Kim, and then redundantly by Fujimura. In sum, this possible combination would waste substantial processing (and power) resources in direct contravention of the purposes of the ’645 Patent

181. Assume instead that a pattern was fed into the input of Kim. In that circumstance, Kim might output an “Adjusted image g” that does not correct the pattern. That said, since the pattern in FIG. 1 still features a black stripe at the bottom (see above), Fujimura might still correct the portions above that black bar, meaning that the pattern would still be corrected by the system. In other words, the output of Fujimura might totally defeat the entire operating principle of Kim to not correct the pattern.

B. Claim 5

1. Limitations [5.b] and [5.c]

182. Claim limitation [5.b] recites “*a pattern portion detector which detects whether a pattern portion other than contents is contained in the video signal input to the input unit,*” and claim limitation [5.c] recites: “*a no-picture area detector which detects whether the pattern portions are no-picture areas having a single color.*” In my view, Petitioner and Dr. Schonfeld fail to show that the combined Fujimura/Kim combination teaches these features for two reasons. First, the proposed combination does not “*detect[] . . . a pattern portion other than contents.*” Second, the proposed combination does not detect whether the “*pattern portions are no-picture areas*” but instead operates on the presumption that all “*pattern portions are no-picture areas.*” Pet. 62.

183. As a threshold matter, I note that Petitioner and Dr. Schonfeld fail to properly address the language of claim 5 as written insofar as they blur the distinction between “*pattern portions*” and “*no-picture areas.*” Petitioner and Dr. Schonfeld purport to re-incorporate their Ground 2 arguments by asserting that the “*pattern portions*” are Fujimura’s “black non-picture bands above and below the picture area.” Pet. 62-63. But this does not properly give weight to the claims, particularly as a POSITA would understand them. After all, by their logic, the Fujimura/Kim reference need never decide “whether the pattern portions are no-

picture areas having a single color” because the “*pattern portions*” calculated by Fujimura (e.g., by counting dark pixels) will always be “*no-picture areas having a single color*.” That is, Fujimura never has a scenario where the “*pattern portions*” are not large dark stripes corresponding to (for example) letterboxing. In the world of Fujimura, all “*pattern portions*” have a “*single color*” and are “*no-picture areas*.” In turn, in the combination of Fujimura and Kim proposed by Petitioner and Dr. Schonfeld, there is thus no need for a “*no-picture area detector*” in the first place, as Petitioner’s read of the “*pattern portion detector*” would already guarantee that a “*no-picture area[]*” was present. Petitioner and Dr. Schonfeld’s attempts at averring to Fujimura’s different approaches to black regions (either dark pixel counting or use of an identifier) do not change this conclusion: these are alternative approaches for identifying letterboxing, not two different steps that can be taken sequentially. See EX1005, 15:8-12.

184. Petitioner and Dr. Schonfeld defend their proposed read of “*no-picture area[s]*” by arguing that aspects of the claims are “functional[]” and not “structural[],” but this argument misses the point. No matter what entity is pointed at, there is no entity in the proposed Fujimura/Kim combination that detects “*whether the pattern portions are no-picture areas having a single color*,” which is a functional step. That is, the deficiency is not structural, it is functional: there is simply no need for the system to determine “*whether*” when there is no circumstance

in Fujimura where the “*pattern portions*” are not “*no-picture areas*.” In other words, even if the claim only “functionally” required (1) detecting a “*pattern portion*” and then (2) determining whether that “*pattern portion*” is a “*no-picture area*,” the second step would be unnecessary in Fujimura because Fujimura’s system is exclusively designed to identify letterboxing no-picture areas.

185. Accordingly, Petitioner and Dr. Schonfeld have failed to show that the combined Fujimura/Kim combination would have taught the subject matter of claim limitations [5.b] and [5.c].

2. Limitation [5.e.i]

186. Claim limitation [5.e.i] recites “*a controller which controls the corrector to cause the corrector to correct the video signal input to the input unit when the pattern portions are not contained and when the pattern portions are the no-picture areas*.” Petitioner and Dr. Schonfeld rely on similar rationale to Ground 2, limitation [1.d] as allegedly teaching these features. See Pet. 45-48, 66-67. But it is my opinion that the Fujimura/Kim combination fails to teach the “*controller*” here for at least the same reasons as I provide above regarding Ground 2, limitation [1.d]. For example, I note that Petitioner fails to identify a “*controller*” in the first place for at least the same reasons as provided above.

187. In particular, I note that Petitioner’s and Dr. Schonfeld’s assertion that the “vertical limiter 47” is the claimed “*controller*” fails here because Fujimura’s

“vertical limiter 47” does not “*correct the video signal input to the input unit when the pattern portions are not contained and when the pattern portions are the no-picture areas.*” In Fujimura, there is no distinction between “*pattern portions*” and “*no-picture areas.*” Thus, there is no way that Fujimura could decide both (1) “*when the pattern portions are not contained*” and (2) “*when the pattern portions are the no-picture areas.*”

188. It is further my opinion that Kim does not remedy the deficiencies of Fujimura at least because there is no feasible way that Kim’s functionality could be combined to improve the control of Fujimura’s “vertical limiter 47.” Fujimura’s vertical limiters are, as their name implies, focused on controlling the vertical scan lines for (e.g.,) luminance and/or chrominance enhancement. In turn, a POSITA would recognize that no element in Kim would transform these line number-focused elements into elements that could control frame-level enhancement “*when pattern portions are*” or are not contained, much less to decide to do so based on whether “*pattern portions are the no-picture areas.*” Moreover, based on my review of the various documents, neither Petitioner nor Dr. Schonfeld explain how such a modification/improvement would be implemented.

3. Limitation [5.e.ii]

189. Claim limitation [5.e.ii] recites “*a controller which . . . which controls the corrector to cause the corrector not to correct the video signal when the pattern*

portions are not the no-picture areas.” It is my opinion that both Petitioner and Dr. Schonfeld fail to establish that claim limitation [5.e.ii] would be rendered obvious in view of Fujimura and Kim. This is for at least the same reasons I provide above regarding limitation [5.e.i], as well as for the many reasons described above regarding the deficiencies of the proposed combination as a whole. Pet. 67-71. After all, as I’ve indicated above, Fujimura does not distinguish between “*pattern portions*” and “*no-picture areas*,” and it’s far from clear how Kim would modify the “vertical limiter 47” (the alleged “*controller*”) to account for “*pattern portions [that] are not the no-picture areas.*”

190. I particularly disagree with Petitioner and Dr. Schonfeld’s ignoring of the difficulties inherent in combining Fujimura and Kim as it pertains to this step. I note that, after relying on Fujimura to disclose the other limitations of claim 5 (Pet. 59-67), Petitioner alleges that “a POSITA would have been motivated to add Kim’s functionality to Fujimura to account for such patterns for which Fujimura does not account.” Pet. 71. This assertion is far from clear: it’s not quite clear why a POSITA would be worried about “such patterns for which Fujiura does not account,” especially since Fujimura doesn’t describe patterns in the first place and because Petitioner and Dr. Schonfeld have failed to identify what issues would arise from not addressing such other “patterns” in the first place. Regardless, as I’ve detailed above, combining Kim and Fujimura in either way (*e.g.*, Kim output to Fujimura input, or

vice versa) introduces a variety of issues, including but not limited to issues with redundant processing leading to over-processed images and/or wasteful enhancement efforts, even including circumstances where the entire purpose of Kim might be defeated. Accordingly, it is my opinion that, even if a POSITA were somehow motivated to combine the references, doing so would be an onerous task that would introduce a wide variety of issues that could not be easily corrected by a POSITA. That is, in my view, the desire to “account for such patterns to which Fujimura does not account” is not sufficient explanation as to how these many hurdles would be overcome. It is still not even clear to me which issues are allegedly being addressed in Fujimura via the addition of Kim, other than some nebulous concept of handling additional “patterns.”

191. For at least the foregoing reasons, in my opinion, Dr. Schonfeld fails to show a reasonable likelihood of success in establishing that claim limitation [5.e.ii] would have been rendered obvious based on Fujimura and Kim.

C. Claims 6-8

192. Claims 6-8 depend from claim 5. Therefore, for at least the reasons provided above in relation to claim 5, in my opinion, Petitioner and Dr. Schonfeld fail to establish that claims 6-8 would have been rendered obvious based on Fujimura and Kim.

XI. CONCLUSION

193. In addition to the opinions and evidence expressed herein, I reserve the right to rebut any arguments made or evidence presented in response to this report. I also reserve the right to supplement this report based on further investigation or analysis. I may also use graphic exhibits and/or demonstratives to help illustrate the facts and opinions I have expressed herein.

APPENDIX A

CURRICULUM VITAE

Matthew A. Turk, Ph.D.

Fellow, Association for Computing Machinery (ACM)
Life Fellow, Institute of Electrical & Electronics Engineers (IEEE)
Fellow, International Association for Pattern Recognition (IAPR)
Fellow, Asia-Pacific Artificial Intelligence Association (AIIA)
Fellow, Artificial Intelligence Industry Alliance (AIIA)

Santa Barbara Technology Consulting

Professor Emeritus

University of California, Santa Barbara

Department of Computer Science, Santa Barbara, CA 93106-5110

<https://sites.cs.ucsb.edu/~mturk>

mturk@ucsb.edu

+1 (805) 729-0534

PRIMARY RESEARCH INTERESTS AND EXPERTISE:

Computer vision and image processing, artificial intelligence and machine learning, pattern recognition, multimodal human-computer interaction, augmented and virtual reality, computer graphics, mobile imaging, and optics, biometrics, AI ethics and regulation

PROFESSIONAL EXPERIENCE:

2010-pres.	Santa Barbara Technology Consulting Principal Consultant Helping companies with technical, policy, and legal matters related to computing technology and strategy.	Santa Barbara, CA
2000-pres.	University of California, Santa Barbara Professor Emeritus (2019-pres.) Professor (2005-2019), Associate Professor (2000-2005) Co-director, Four Eyes Laboratory Appointments: Computer Science (67%), Media Arts & Technology (33%), Electrical & Computer Engineering (0%), Dynamical Neuroscience (0%) Chair, Department of Computer Science (2017-2019) Chair, Media Arts and Technology (2005-2010) Vice Chair, Media Arts and Technology (2005)	Santa Barbara, CA
2019-2025	Toyota Technological Institute at Chicago President and Professor Member, Board of Trustees	Chicago, IL
2020-2025	Toyota Technological Institute at Japan Board Councilor	Nagoya, Japan
2014-2016	Caugate Co-founder and CEO	Santa Barbara, CA

	Startup company commercializing remote telecollaboration augmented reality software. Participated in UCSB Technology Management Program New Venture Competition and in the Citrix Innovator's Program. Acquired by PTC Inc.; the technology became PTC's Vuforia Chalk product.	
2012	University of Oulu Visiting Professor, Department of Computer Science & Engineering (Jun-Aug)	Oulu, Finland
2011	University of Tampere Visiting Professor, School of Information Science (Aug-Sept)	Tampere, Finland
2003, 2004	Ecole Polytechnique Fédérale de Lausanne (EPFL) Visiting faculty (August 2003, July 2004)	Lausanne, Switzerland
1994-2000	Microsoft Research Researcher Founded the Vision Technology Research Group; research in computer vision, vision-based human-computer interaction and perceptual user interfaces.	Redmond, WA
1993-94	Teleos Research Computer Scientist Research in vision-based interaction with people, object recognition, mobile robots.	Palo Alto, CA
1993	Stanford University Lecturer Computer Science Department	Palo Alto, CA
1992	LIFIA-IMAG Postdoc / Visiting Researcher Research in face recognition and visual interpretation of human gestures, applications to human-computer interfaces.	Grenoble, France
1991	Massachusetts Institute of Technology Postdoctoral Fellow, MIT Media Laboratory Research on human face recognition for applications to security and man-machine communication; image database indexing and retrieval.	Cambridge, MA
1984-87	Martin Marietta Denver Aerospace Engineer, Senior Engineer Research in vision algorithm development and implementation for mobile robot navigation (DARPA Autonomous Land Vehicle program).	Denver, CO
1983-84	University of Pittsburgh Computer Technician, Dept. of Neurophysiology Electronics, image processing, and computer system support.	Pittsburgh, PA

EDUCATION:

- 1987-91 **Massachusetts Institute of Technology** Cambridge, MA
Ph.D. from the Media Laboratory, Vision and Modeling Group
Committee: Alex P. Pentland (advisor), Ted Adelson, Nicholas Negroponte
Dissertation: *Interactive-Time Vision: Face Recognition as a Visual Behavior*
The dissertation introduced “Eigenfaces,” an appearance-based approach to face and object recognition. A prototype system was built to track and recognize people as they entered a room; we showed how this approach could be used to represent, detect, and recognize other object properties such as facial expression. Papers on this work received an “Outstanding Paper” award (1991) and a “Most Influential Paper of the Decade” award (2000).
- 1982-84 **Carnegie Mellon University** Pittsburgh, PA
M.S. in Electrical and Computer Engineering
Advisors: Matt Mason, Marc Raibert
Thesis: *A Fine Motion Planning Algorithm for Robots*
The thesis investigated robot manipulation planning techniques in the face of uncertainty in sensing and world modeling. A 2D planner was developed to automatically construct a plan, by reasoning in configuration space, to successfully manipulate an object along a constrained path.
- 1978-82 **Virginia Tech (VPI&SU)** Blacksburg, VA
B.S. in Electrical Engineering, *magna cum laude*
Advisor: Robert Haralick
Senior Honors Project in computer vision; segmentation algorithms implemented in the GYPSY image processing system.

RECENT EXPERT TESTIFYING EXPERIENCE (2022-2026):

- 2026 Cerence AI in the Matter of Certain Smart Televisions
U.S. International Trade Commission
Investigation No. 337-TA-1461
Declaration on Claim Construction
- 2025-2026 FaceTec, Inc. v. Jumio Corp.
USPTO Patent Trial and Appeal Board
Case IPR2025-00106, -00107, -00108, -00109
Expert Declaration, Deposition
- 2024-2025 Hayden AI Technologies, Inc. v. Safe Fleet Holdings LLC et al.
Case No. 1:23-CV-03471
Eastern District of New York and Western District of Washington
Declaration on Claim Construction, Deposition
- 2024 Avelardo Rivera and Yasmine Romero et al. v. AWS
U.S. District Court Western District of Washington at Seattle
Case No. 2:22-cv-00269-JHC
Expert Report

- 2024 RoboticVISIONTech, Inc. v. ABB Inc.
U.S. District Court for the District of Delaware
Case No. 1:22-cv-01257-GBW
Declaration on Claim Construction, Deposition
- 2023-2024 NantWorks, LLC and Nant Holdings IP, LLC v. Niantic, Inc.
U.S. District Court Northern District of California, San Francisco Division
Case No. 3:20-cv-06262-LB
Expert Report, Rebuttal Expert Report, 2 Depositions
- 2022-2024 The State of Texas v. Meta Platforms, Inc., F/K/A Facebook, Inc.
District Court, 71st Judicial District, Harrison County, Texas
Cause No. 22-0121
Expert Report, Deposition
- 2022-2024 Volkswagen Group of America v. Yechezkal Evan Spero
USPTO Patent Trial and Appeal Board
Cases IPR2022-01586, IPR2022-00197, IPR2023-00315, IPR2023-00328, IPR2023-00318, IPR2023-00335, IPR2023-00336
Mercedes-Benz USA, LLC v. Yechezkal Evan Spero
USPTO Patent Trial and Appeal Board
Cases IPR2023-01026, IPR2023-01027, IPR2023-01039, IPR2023-01040, IPR2023-01034
23 Declarations, 5 Depositions
- 2022 Samsung Semiconductor, Inc. v. Gerard “Dirk” Smits
JAMS Arbitration Ref. No. 1100111885
2 Expert Reports
Deposition, Arbitration Hearing
- 2021-2022 Indect USA Corp v. Park Assist
District Court for the Southern District of California
Case No. 3:18-cv-2409-BEN-MDD
Expert Report, Deposition, Trial

HONORS AND AWARDS:

- 2024 Recognized by the IEEE as *IEEE Life Fellow*
- 2023 Elected as *AIIA Fellow* (Artificial Intelligence Industry Alliance)
- 2022 Elected as *AAIA Fellow* (Asia-Pacific Artificial Intelligence Association)
- 2022 Appointed to the *Computing Community Consortium (CCC) Council*, charged with catalyzing and empowering the U.S. computing research community to articulate and advance major research directions for the field (term: 2022-2025)
- 2020 Elected as *ACM Fellow* (Association for Computing Machinery) for “contributions to face recognition, computer vision, and multimodal interaction”
- 2016 *Best Paper Honorable Mention* at the 2016 IEEE Symposium on 3D User Interfaces (3DUI) for “Interpreting 2D Gesture Annotations in 3D Augmented Reality,” with B. Nuernberger, K. Lien, and T. Höllerer
- 2015 *Winner, ACM Multimedia Open Source Software Competition* for “Theia: A Fast and Scalable Structure-from-Motion Library,” with C. Sweeney and T. Höllerer

- 2015 *Best Short Paper Award* at the 2015 International Symposium on Mixed and Augmented Reality (ISMAR), for “Efficient Computation of Absolute Pose for Gravity-Aware Augmented Reality,” with C. Sweeney, B. Nuernberger, and T. Höllerer
- 2015 *Outstanding Reviewer Award* at the 2015 IEEE International Conference on Automatic Face and Gesture Recognition
- 2014 Elected as *IAPR Fellow* (International Association for Pattern Recognition) for “contributions to computer vision and vision-based interaction”
- 2014 Received inaugural *ICMI Community Service Award* for organizational and service contributions to the multimodal interaction research community
- 2012 Elected as *IEEE Fellow* (Institute of Electrical and Electronics Engineers) for “contributions to computer vision and perceptual interfaces”
- 2012 *Best Paper Award* at the 2012 International Symposium on Mixed and Augmented Reality (ISMAR), for “Live tracking and mapping from both general and rotation-only camera motion,” with S. Gauglitz, C. Sweeney, J. Ventura, and T. Höllerer
- 2012 *Best Paper Honorable Mention* at the 2012 International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI), for “Integrating the physical environment into mobile remote collaboration,” with S. Gauglitz, C. Lee, and T. Höllerer
- 2012 *Best Student Paper Finalist* (PhD student Victor Fragoso) at the 2012 International Conference on Image Processing (ICIP), for “Locating Binary Features for Keypoint Recognition using Noncooperative Games,” with V. Fragoso and J. Hespanha
- 2012 Selected to participate in the National Academy Keck Futures Initiative on The Informed Brain in a Digital World (invitation only)
- 2011 Awarded the *2011-2012 Fulbright-Nokia Distinguished Chair in Information and Communications Technologies*
- 2010 *Best Paper Award* at the 2010 IEEE International Workshop on Mobile Vision, for “Location-based augmented reality on mobile phones,” with R. Paucher
- 2006 *One of the Best Image Processing and Computer Vision Papers* in SIBGRAPI 2006, for “Dealing with multi-scale depth changes and motion in depth edge detection,” with R. Feris and R. Raskar
- 2004 *Best Paper Award* at the 2004 IEEE Workshop on Real-Time Vision for Human Computer Interaction, for “Fast 2D hand tracking with flocks of features and multi-cue integration,” with M. Kölsch
- 2004 *Communication and Technology Top Paper Award*, for “Non-zero sum gaze and persuasion,” with J. Bailenson, A. Beal, J. Blascovich, and J. Loomis; selected for presentation at the 54th Annual Conference of the International Communication Association (2004)
- 2000 *Most Influential Paper of the Decade Award* from the International Association for Pattern Recognition (IAPR) Workshop on Machine Vision Applications (MVA-2000)
- 1999 Selected to attend the National Academy of Engineering Symposium on Frontiers of Engineering (one of 70 chosen nationwide)
- 1992 Selected to attend *Comparative Approaches to Cognitive Science* international summer school (with scholarship)
- 1991 C.N.O.U.S. post-doctoral fellowship grant (France)
- 1991 IEEE Computer Society Outstanding Paper Award, Conference on Computer Vision and Pattern Recognition (CVPR), for “Face recognition using eigenfaces,” with A. Pentland
- 1988-90 SPIE Scholarships in Optical Engineering

1990 MIT Japan Science, Technology, Management Prize
 1988 Author of the Year award, Martin Marietta Information Systems , for “VITS – a vision system for autonomous vehicle navigation,” with D. Morgenthaler, K. Gremban, and M. Marra
 1978-82 Marshall Hahn Engineering Scholarship (Virginia Tech)

SELECT KEYNOTE AND INVITED TALKS:

Oct 2025 Panelist, CCC Community Chat, *Envisioning Possible Futures for AI Research* (Webinar)
 May 2024 Invited Speaker, IEEE Computer Society San Diego Chapter (San Diego, CA)
 Feb 2024 Session Organizer and Panel Moderator, *Generative AI and Science*, AAAS Annual Conference (Denver, CO)
 Jan 2023 Keynote Speaker, IEEE International Conference on Face and Gesture Recognition (Kona, HI)
 Jan 2023 Keynote Speaker, WACV Workshop on Demographic Variations in Performance of Biometric Algorithms (Kona, HI)
 Feb 2022 Milestone Systems (Brøndby, Denmark)
 Jan 2022 Keynote Speaker, WACV Workshop on Real-World Surveillance: Applications and Challenges (Waikoloa, Hawaii)
 Dec 2021 Keynote Speaker, International Conference on 4th Industrial Revolution and Beyond (Dhaka, Bangladesh)
 Oct 2021 Keynote Speaker, IEEE International Workshop on Machine Learning for Signal Processing
 Mar 2021 Brandeis University (Waltham, MA)
 Nov 2020 Keynote Speaker, IEEE Conference on Automatic Face and Gesture Recognition
 Aug 2020 Invited Speaker, ECCV Workshop on Fair Face Recognition and Analysis
 Mar 2020 Invited Speaker and Panelist, California State Assembly Committee on Privacy and Consumer Protection (Sacramento, CA)
 Nov 2019 Distinguished Speaker, Ohio State University ECE Department (Columbus, OH)
 Oct 2019 Invited speaker, ICCV Workshop on Real-World Recognition from Low-Quality Images and Videos (Seoul, South Korea)
 Oct 2019 Toyota Technological Institute Japan (Nagoya, Japan)
 Jul 2019 Keynote speaker, 14th International Symposium on Signals, Circuits, and Systems (Iasi, Romania)
 Aug 2018 Invited talk, Forum on The Future of ISEA (Port Hueneme, CA)
 Mar 2018 University of Primorska (Slovenia)
 Mar 2018 Arizona State University
 Jul 2017 PTC (San Diego, CA)
 Jun 2017 Keynote speaker, Global Virtual Reality Conference (CVRC) (Shanghai, China)
 Jun 2017 Invited talk, Shanghai Tech (Shanghai, China)
 Feb 2017 Santa Barbara Science & Religion Study Group
 Nov 2016 Keynote speaker, The Chinese Conference on Pattern Recognition (Chengdu, China)
 Oct 2016 Invited talk, Science and Engineering Council of Santa Barbara (Santa Barbara, CA)
 May 2016 UCSB Dean’s Cabinet
 Apr 2016 Invited talk, Field Service USA 2016 (Palm Springs, CA)
 Apr 2016 Invited talk, Computer Science Academy, Santa Barbara High School (Santa Barbara, CA)

Mar 2016	Invited panelist, Graduate Student Workshop on Computing, UCSB (Santa Barbara, CA)
Feb 2016	University of Massachusetts, Amherst (Amherst, MA)
Oct 2015	University of Notre Dame (South Bend, IN)
Sept 2015	Invited talk, Andreessen Horowitz Academic Roundtable (Menlo Park, CA)
Sept 2015	Invited talk, Citrix Online (Santa Barbara, CA)
June 2015	Keynote speaker, 4 th International Conference on Informatics, Electronics, and Vision (Fukuoka, Japan)
May 2015	Keynote speaker, 11 th IEEE International Conference on Face and Gesture Recognition (Ljubljana, Slovenia)
May 2015	Invited panelist, 11 th IEEE International Conference on Face and Gesture Recognition (Ljubljana, Slovenia)
Mar 2015	Invited speaker, San Marcos High School Distinguished Educator/Innovative Researcher (Santa Barbara, CA)
Dec 2014	Keynote speaker, 17 th International Conference on Computer and Information Technology (Dhaka, Bangladesh)
Dec 2014	Daffodil University (Dhaka, Bangladesh)
Nov 2014	Zhejiang University (Hangzhou, CA)
Nov 2014	CTO Forum: Rethink Disruption (San Francisco, CA)
Jan 2014	Keynote speaker, Gsolutionz, Inc. (Carpinteria, CA) annual company meeting
Dec 2013	Panelist, ICCV Workshop on Visual Commerce
Oct 2013	Ohio State University
Jul 2013	Google (Mountain View, CA)
Apr 2013	Amazon (Seattle, WA)
Sept 2012	Proceedings of the IEEE 100 th Anniversary Forum on Improving Quality of Life Through Engineering Innovations (scheduled keynote)
Aug 2012	University of Oulu, Finland
May 2012	Invited talk, HK-UST International Workshop on Embedded System Design
Apr 2012	Qualcomm Research (San Diego, CA)
Aug 2011	University of Oulu, Finland
Aug 2011	University of Tampere, Finland
Aug 2011	Nokia Innovation Center, Tampere, Finland
Apr 2011	University of Texas, Austin
Mar 2011	Keynote speaker, Infoplosion Symposium (Tokyo, Japan)
Mar 2011	University of Kyoto
Feb 2011	University of Houston
Jan 2011	University of California, Riverside
Nov 2010	Keynote speaker, 15th Ibero-American Congress on Pattern Recognition (Sao Paulo, Brazil)
Sept 2010	Keynote speaker, IEEE Fourth International Conference On Biometrics: Theory, Applications and Systems (BTAS 2010), Washington, D.C.
Jul 2010	Lecturer, Sino-USA Summer School in Vision, Learning and Pattern Recognition (Xi'an, China)
Feb 2010	University of Denver (Denver, CO)
Apr 2010	Rensselaer Polytechnic Institute (Troy, NY)

GRANTS, CONTRACTS, AND INDUSTRY GIFTS:

2019-2022	“Robust Inside-Out Simultaneous Localization and Mapping for Environment Monitoring and Equipment Maintenance,” U.S. Navy (PI), \$447,845
2018-2019	“EAGER: Attention-Aware Mixed Reality Interfaces,” NSF (Co-PI), \$244,997
2015	Equipment gift (in-kind), Nokia Corp., OZO professional VR camera, \$60,000
2015-2017	“One+ Class Support Vector Machine Learning for Interactive Object Detection,” U.S. Navy, \$47,000
2015-2016	“Improving Live Telecollaboration,” Citrix Online, \$80,000
2015	Equipment gift (in-kind), FLIR Systems, Inc.: FLIR ONE thermal infrared cameras
2014-2015	“Eye Gaze Correction for Improving Video Interaction,” Citrix Online, \$70,500
2014-2017	“Crowd-Sourcing the World: Scalable Methods for Dynamic Structure from Motion,” NSF (PI), \$477,428
2012-2015	“US-Finland Planning Visit: Transformed Social Interaction and Telecollaboration for Collaborative Learning,” NSF (PI), \$40,791
2012-2016	“Telecollaboration in Physical Spaces,” NSF (PI), \$499,970
2012-2015	“Interactive Panoramas on Google Glass,” Google, Inc. Google Glass Research Awards Program, \$18,000 + \$4500 equipment gift (in-kind)
2011-2012	Equipment gift (in-kind), NVIDIA Research: Tegra Tablet, \$1500
2009-2013	“CRI: Equipping the Allosphere, an Environment for Immersive Data Exploration,” NSF (PI), \$749,894
2010	Research and equipment gift funding, Nokia Corp., \$9,600
2009	Equipment gift (in-kind), Nokia Corp., \$11,033
2009	Equipment gift (in-kind), HRL Labs, \$16,832
2009	Research gift funding, Nokia Corp., \$10,000
2008-2011	Internal funding for Allosphere facility and research, UCSB (PI), \$622,052
2008-2011	“MRI: Development of the Allosphere, an Immersive Instrument for Scientific Exploration,” NSF (PI), \$500,000
2008-2009	“Scalable Visualization and Constrained Interaction for Large Graphs – Supporting the Collaborative Analysis of High-dimensional Data Sets,” NSF (Co-PI), \$263,000
2006-2007	“Scalable Visualization and Constrained Interaction for Large Graphs – Supporting the Collaborative Analysis of High-dimensional Data Sets,” NSF (Co-PI), \$230,000
2008-2009	“Multimodal Wireless Sensor Network Infrastructure,” DARPA (Key personnel), \$655,174
2006-2007	“Scalable Visualization and Constrained Interaction for Large Graphs,” DOD/NSF (Co-PI), \$234,321
2005-2009	“A Tangible Interaction Window between Korea and the United States,” Korean Institute of Science and Technology (Co-PI), \$274,605
2006	“Foundations of Multimedia Research,” UC Opportunity Award, \$14,950
2005-2008	“Detecting and Analyzing Discontinuities in Computer Vision,” NSF (PI), \$328,303
2003	Microsoft unrestricted gift, \$65,000
2003	“STTR Phase I: Sensors and Methods to Handle UAV,” U.S. Navy Air Systems Command (PI, subcontract to Develosoft Corp.), \$21,000
2003	Lawrence Livermore Laboratory UCRP Award (PI), \$40,000
2003	Microsoft Research Learning Science and Technology (co-PI), \$40,000
2003	Mitsubishi Equipment Gift, \$650

2003	UCSB Instructional Improvement Grant (PI), \$12,150
2003	DiMI Opportunity Award (PI), \$14,000
2003	Microsoft Equipment Gifts, \$50,000
2003-2008	NSF, “Digital Multimedia IGERT: Graduate Training Program in Interactive Digital Multimedia” (Co-PI), \$3,426,376
2002-2005	NSF, “ITR: Using Virtual Environment Technology to Understand and Augment Social Interaction” (Co-PI), \$1,100,000
2002	UCSB Research Across Disciplines (Co-PI), \$14,400
2002	UCSB Research Across Disciplines (Co-PI), \$11,000
2001	DiMI Opportunity Award (Co-PI), \$8000

TEACHING EXPERIENCE:

(* - created new course)

2000-2019	<i>Graduate courses:</i> Human Computer Interaction Technologies*, Computer Imaging*, Mobile Imaging*, Computer Vision, Probabilistic Models and Methods in Computer Science*, Artificial Intelligence, Multimodal Interaction on Mobile Computing Platforms* <i>Undergraduate courses:</i> Foundations of Computer Science, Computer Graphics, Artificial Intelligence*, Machine Learning, Introduction to Computer Vision, Introduction to C, C++, and Unix <i>Seminar courses:</i> Topics in Computer Vision, Human-Computer Interaction, A History of Computing*, Perceptual User Interfaces*, Visualization, Media Arts and Technology*
2012	Mobile Computer Vision course, Computer Science and Engineering Department, University of Oulu, Finland
2011	Computational Illumination course, School of Information Sciences, University of Tampere, Finland
2010	Guest lecturer, Sino-US Summer School in Vision, Learning, and Pattern Recognition (Perception, Motion, and Events), Xi'an, China
1993	Lecturer, Stanford University – Taught <i>Concurrent Programming</i> (CS140) in the Department of Computer Science, televised via the Stanford Instructional Television Network.
1990, 1991	MIT Media Lab – Co-organized and co-taught <i>Practical Issues in Color Processing</i> (4.999), lecturing on color imaging and human color vision.*
1989-90	MIT – Guest lecturer at MIT Summer Course on flight simulation.
1989-90	Graduate Tutor at “pika,” an MIT undergraduate living group. Responsible for tutoring students in a variety of subjects.
1986	Created and taught <i>Computer Vision</i> course (CS-369) for the Martin Marietta Institute *
1985-86	Organized weekly computer vision seminars at Martin Marietta. Lectured on topics in vision and AI.

STUDENTS SUPERVISED:

Postdoctoral researcher supervised:

Changbo Hu (2001-2003)

Ismo Rakkolainen (2004-2006)

Jae Sik Chang (2005-2007)

Chunghoon Kim (2007-2009)
Stefan Arisona (2007-2008)
Masahiro Toyoura (2008-2009)
Erno Makinen (2009)
Steffen Gauglitz (2014)
Julia Kuosmanen (2015)

Ph.D. Thesis Committees Chaired (in addition to 25+ M.S. committees chaired and 27+ undergraduate projects directed):

UCSB Computer Science students, unless otherwise noted

Rainer Stiefelwagen (University of Karlsruhe, co-chair), 2002
Mathias Kölsch, 2004
Rogerio Feris, 2006
Ya Chang, 2006
Haiying Guan, 2007
Longbin Chen, 2010
Daniel Vaquero, 2012
Steffen Gauglitz (co-chair), 2014
Victor Fragoso, 2014
Chris Sweeney (co-chair), 2016
Kuo-Chin Lien (ECE), 2016
Domagoj Baricevic (co-chair), 2016
Dianna Han, 2017
Ben Nuernberger (co-chair), 2017
Jedrzey Kozerański, 2021
Pushkar Shukla (TTIC), 2025

SELECT PROFESSIONAL ACTIVITIES AND SERVICE:

Academic advisory boards and external reviews:

Member, International Advisory Board, Idiap Research Institute, Martigny, Switzerland (2021-present)
Member, Advisory Board, CHIL (Computers in the Human Interaction Loop) Program, University of Karlsruhe (2005)
Member, Traumatic Brain Injury Resource Optimization Center Advisory Board (2008-2018)
Member, Project Career Advisory Board, National Institute on Disability and Rehabilitation Research (NIDDR) Field Initiated Program research study on Cognitive Support Technologies for Traumatic Brain Injury, (2014-2018)
External Reviewer, University of Toronto Department of Computer Science (2022)
External Reviewer, John Hopkins University Department of Computer Science and Engineering (2021)
External Reviewer, Virginia Tech Center for Human Computer Interaction (2017)
Member, External Review Committee for Korean Institute of Science and Technology (2009)
Member, DARPA IXO Immersive Operations Planning Panel (2006-2007)
Member, NSF Committee of Visitors for CISE-IIS (2005)

Journal editorships, conference board positions, professional society positions, key service:

Member, CRA Computing Community Consortium (CCC) (2022-2025)
Founding Associate Editor, ACM Transactions on Interactive Intelligent Systems (2009-present)

Chair, Editor-in-Chief Search Committee, ACM Transactions on Interactive Intelligent Systems (2015)
 Associate Editor, Journal of Image and Vision Computing (2006-2019)
 Associate Editor, International Journal of Computer Vision and Signal Processing (2011-present)
 Guest Editor, Special Issue on Behavior Understanding for Arts and Entertainment, ACM Transactions on Interactive Intelligent Systems (TiiS) (2015)
 Guest Editor, Special Issue on Machine Learning for Vision Based Motion Analysis, Journal of Image and Vision Computing (2012)
 Guest Editor, Special Issue on Real-World Face Recognition, IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI) (2011)
 Guest Editor, Special Issue on Mobile Computer Vision, International Journal of Computer Vision (2011)
 Chair, ICMI Steering Committee (2006-2009)
 Member, ACM ICMI Steering Committee (2003-2015)
 Member, ACM ICMI Advisory Committee (2024-pres.)
 Chair, IEEE PAMI-TC Open Access Committee (2013)
 Member, Advisory Board, IEEE International Conference on Imaging, Vision, & Pattern Recognition (2016-present)
 Member, STEAM Advisory Council, MOXI: The Wolf Museum of Exploration and Innovation, Santa Barbara, CA (2012-2016)
 Member, IEEE Automatic Face and Gesture Recognition Steering Committee (2011-2015)
 Member, IEEE International Conference on Social Computing Steering Committee (2010-2015)
 Member, ACM Transactions on Interactive Intelligent Systems (TiiS) Best Article Award Committee (2015)
 Member, Maria Petrou Prize Committee, International Association for Pattern Recognition (2022-2028)

Key organizing committee positions:

IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (General Chair 2014, Area Chair 2001, 2007, 2009, 2012, 2017, 2019, 2022, 2026)
 International Conference on Computer Vision (ICCV) (Area Chair 2019, 2021, 2025)
 IEEE Winter Conference on Applications of Computer Vision (WACV) (Program Chair 2017, Area Chair 2005, 2024, Best Paper Award Committee 2023)
 International Conference on Informatics, Electronics & Vision (General Chair 2012, 2013, 2014, 2015, 2016, 2019, 2021, 2023)
 IEEE Conference on Automatic Face and Gesture Recognition (General Chair 2011, Special Session Chair 2008, 2013, Test of Time Award Committee 2013, Best Paper Award Committee 2023, Area Chair 2025)
 ACM Conference on Multimedia (General Chair 2006)
 International Conference on Multimodal Interfaces (ICMI) (General Chair 2008, 2019, Paper Awards Committee Chair 2007, 2008, 2014, Program Chair 2004, Area Chair 2005, 2006, Publicity Chair 2010, Awards Committee 2007, 2008, 2014, 2016, 2025)
 ACM CHI (Area Chair 2001, Area Chair 2013, Associate Chair for CHI Notes 2006)
 IEEE Workshop on Analysis and Modeling of Faces and Gestures (AMFG) (General Chair 2013, 2018, Honorary Chair 2021)
 IEEE Workshop on Recognizing Families In the Wild (RFIW) (Honorary Chair 2020)
 ACM Conference on Intelligent User Interfaces (IUI) (Senior Program Committee 2018)
 IEEE Workshop on CVPR for Human Communicative Behavior Analysis (2008, 2009, 2010, 2011)

IEEE Workshop on Machine Learning for Vision-Based Motion Analysis (2011)
 Workshop on Media Arts, Science, and Technology (2009)
 Workshop on Perceptive User Interfaces (2001)
 Workshop on Multimodal User Authentication (2003, 2006)
 DiMI Workshop on Perceptive Animated Interfaces (2003)
 NSF Virtual Human Workshop (2004)
 Award Committee, Outstanding Young Researcher in Automatic Human Behaviour Analysis (2011)
 Member, ACM SIGIR Best Papers Committee (2004)

UNIVERSITY SERVICE AT UC SANTA BARBARA:

Campus and UC Level Service

2018-2019	Proposing team and advisory board, Mellichamp Academic Initiative for Mind and Machine Intelligence
2017-2019	Faculty Grievance Advisor to the Committee on Privilege and Tenure
2017	Judge, Grad Slam Competition
2016-2019	Faculty Advisor, UCSB Machine Learning Club
2015	Advisor, TMP New Venture Competition Finalist Team
2014-2019	Affiliate, Center for Digital Games Research
2013-2019	Member, Executive Council, SAGE Center for the Study of the Mind
2011-2015	Member, Committee on Privilege and Tenure
2009-2019	Member, Steering Committee, Center for Information Technology and Society (CITS)
2009-2019	Member, Steering Committee, Cognitive Science Program
2008-2019	Member, Executive Committee, Center for Spatial Studies
2007-2009	Member, Council on Planning and Budget
2006-2010	Member, CNSI Administrative Committee
2006-2009	UCSB Representative, IUCRP Digital Media Executive Committee
2006	Member, Academic Personnel Ad Hoc Committee
2005-2008	Member, College of Engineering Administrative Committee
2004-2008	Founding Member, Transliterations Project
2002-2005	Member, Central Fellowships Committee
2002	Member, Dissertation Awards Committee
2001-2004	Member, Graduate Council

Primary Department Level Service

2017-2019	Chair, Department of Computer Science
2016-2017	Chair, CS Faculty Recruiting Committee
2013	Chair, CS Business Officer Search Committee
2012-2013	Chair, MAT Graduate Admissions Committee
2011-2019	Chair, CS Public Relations Committee
2009-2010	Chair, MAT Academic Program Review Committee
2007-2009	Chair, MAT Faculty Search Committee
2006-2010	Chair, MAT Curriculum Committee
2005-2010	Chair, MAT Web and Public Relations Committee
2005-2010	Chair, Media Arts and Technology Graduate Program
2005-2010	Chair, MAT Graduate Program

2005 Vice Chair, Media Arts and Technology Graduate Program
 2004-2006 Chair, MAT By-Laws Committee
 2003-2007 Co-Chair, MAT Colloquium Series Committee
 2003-2005 CS Graduate Advisor
 2003-2005 Chair, CS Graduate Affairs and Advising Committee
 2001-2002 Chair, MAT Graduate Admissions Committee
 2000-2001 Chair, CS External Relations Committee

CONSULTING (selected):

2017-pres. Clear Protocol, Inc. (Healthcare IT company)
 Advisor
 2010-pres. Various patent-related and other litigation-related consulting engagements
 2016-2018 PTC, Inc. (San Diego, CA)
 Technical consulting on augmented reality for remote collaboration
 2013-2018 Kent State University
 NIDRR Project Career – Development of technology to support the transition of students with traumatic brain injuries from postsecondary education to employment
 2011-2013 3DiVi Inc. (Chelyabinsk, Russia) – 3D gesture recognition
 2011-2012 InTouch Health, Inc. – Computer vision
 2009 Scholastic, Inc.
 2007 I2R, Singapore
 2006 Capstone Press for Inventions and Discovery
 2005 National ICT Australia (NICTA), Sydney, Australia
 2004 Biometrics Engineering Research Center, Yonsei University (Korea)
 2004 Korea Institute of Science and Technology (KIST), Seoul, Korea
 2004 Samsung Corporation (Korea)
 2001 Toyon Corporation (Santa Barbara)

PATENTS:

2016 U.S. Patent #9,495,761 – “Environment Mapping with Automatic Motion Model Selection,” with S. Gauglitz, C. Sweeney, J. Ventura, and T. Höllerer
 2004 U.S. Patent #6,674,877 – “System and method for visually tracking occluded objects in real time,” with N. Jojic
 1999 German Patent DE69,130,616, “A Face Recognition System,” with A. Pentland
 1992 US Patent #5,164,992: “A Face Recognition System,” with A. Pentland

OPEN SOURCE SOFTWARE, DATA SETS:

2015 Theia: A Fast and Scalable Structure-from-Motion Library, available at <http://www.theia-sfm.org/>
 Winner, ACM Multimedia Open Source Software Competition (C. Sweeney, T. Höllerer, M. Turk)
 2010 Visual tracking dataset with ground truth, available at <http://ilab.cs.ucsb.edu/index.php/datasets>
 2009 Partial shape matching source code, available at

- 2004 <https://code.google.com/p/shapematching/source/list>
 “The HandVu Vision-Based Hand Gesture Interface,” available at
<http://www.movesinstitute.org/~kolsch/HandVu>

PEER-REVIEWED DEMONSTRATIONS:

- 2014 “World-Stabilized Annotations and Virtual Scene Navigation for Remote Collaboration,” S. Gauglitz, B. Nuernberger, M. Turk, and T. Höllerer, ACM Conference on User Interface Software and Technology (UIST), Honolulu, HI, October 2014.
- 2012 “A Prototype Setup to Integrate the Physical Environment into Mobile Remote Collaboration,” S. Gauglitz, C. Lee, M. Turk, and T. Höllerer, MobileHCI, San Francisco, September 2012.
- 2005 “Depth Edges in Real Time using Multi-Flash Camera,” A. Agrawal, V. Branzoi, R. Chellappa, R. Feris, R. Raskar, K. Tan, and M. Turk, CVPR, New York, 2005.
- 2004 “HandVu – Vision-Based Hand Gesture Recognition,” M. Kölsch, M. Turk, and T. Höllerer), ISMAR ’04, Arlington, VA, Oct 31-Nov 5, 2004

CO-AUTHORED REPORTS for the CRA Computing Community Consortium (CCC) Council:

Jensen, D., Danks, D., Elbaum, S., Regli, W., Turk, M., Wierman, A., Yanco, H., Maher, M., Griffin, H., *CCC White Paper: Envisioning Possible Futures for AI Research*, July 2025.

A. Aiken, G. Allen, O. Daescu, D. Danks, S. Elbaum, R. Ghani, C. Gill, W. Gropp, D. Jensen, M. Lin, B. Mosley, M. Parashar, R. Rajaraman, W. Regli, E. Schooler, S. Shekhar, R. Sloan, M. Taufer, M. Turk, H. Wright, H. Yanco, *CRA’s Response to the Request for Information on the Development of an Artificial Intelligence (AI) Action Plan*, March 2025.

M. Taufer, R. Mihalcea, M. Turk, D. Lopresti, A. Wierman, K. Butler, S. Koenig, D. Danks, W. Gropp, M. Parashar, Y. Gil, W. Regli, R. Rajaraman, D. Jensen, N. Bliss, M.L. Maher, *CCC Quad Paper: Now More Than Ever, Foundational AI Research and Infrastructure Depends on the Federal Government*, 2025.

R. Mihalcea, N. Andalibi, D. Jensen, M. Turk, P. Wisniewski, H. Yanco, *CCC Quad Paper: Which Humans? Inclusivity and Representation in Human-Centered AI*, 2025.

D. Danks, C. Gill, I. Foster, W. Gropp, D. Lopresti, M. Parashar, M. Turk, K. Yelick, *CCC’s Response to the Notice of Request for Information (RFI) on Frontiers in AI for Science, Security, and Technology (FASST) Initiative*, November 2024.

D. Danks, C. Gill, M. Lin, D. Lopresti, M. Parashar, W. Regli, M. Turk, *CCC’s Response to the Request for Comments on the U.S. Artificial Intelligence Safety Institute’s Draft Document: Managing Misuse Risk for Dual-Use Foundation Models*, September 2024.

A. Aiken, N. Bliss, D. Danks, C. Gill, D. Jensen, D. Lopresti, M.L. Maher, C. Moore, W. Regli, M. Turk, *CCC’s Response to the Defense Industrial Base Adoption of Artificial Intelligence for Defense Applications*, July 2024.

A. Aiken, N. Bliss, D. Danks, C. Gill, D. Jensen, D. Lopresti, M.L. Maher, C. Moore, W. Regli, M. Turk, *CCC’s Response to the Defense Industrial Base Adoption of Artificial Intelligence for Defense Applications; Notice of Availability*, July 2024.

Bliss, N., Butler, K., Danks, D., Topcu, U., Turk, M., *CCC White Paper: Addressing the Unforeseen Harms of Technology*, June 2024.

N. Bliss, K. Butler, D. Danks, S. Forrest, C. Gill, D. Lopresti, M.L. Maher, H. Mentis, C. Moore, S. Shekhar, A. Stent, M. Turk., *CCC's Response to the National Institute of Justice's Request for Input on Section 7.1(b) of Executive Order 14110, "Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence,"* May 2024.

D. Danks, C. Gill, D. Lopresti, R. Rajaraman, M. Taufer, Ufuk Topcu, M. Turk, H. Yanco, *CCC's Response to the Request for Information (RFI) Related to NIST's Assignments Under Sections 4.1, 4.5 and 11 of the Executive Order Concerning Artificial Intelligence*, February 2024.

D. Danks, H. Griffin, D. Jensen, C. Krintz, D. Lopresti, R. Rajaraman, M. Turk, H. Yanco, *CCC's Response to the Office of Management and Budget's Request for Comments on Advancing Governance, Innovation, and Risk Management for Agency Use of Artificial Intelligence Draft Memorandum*, December 2023.

M. Gini, M. Hunter, S. Koenig, D. Lopresti, R. Rajaraman, U. Topcu, M. Turk, H. Yanco, *CCC's Response to PCAST Working Group on Generative AI Invites Public Input*, July 2023.

J. Biddle, E. Bradley, D. Danks, M. Gini, A. Goel, A. Guha, M. Hunter, D. Jensen, S. Koenig, C. Krintz, D. Lopresti, A. McGovern, D. Molzahn, R. Rajaraman, A. Singh, M. Turk, H. Yanco, *CCC's Response to RFI on National Priorities for Artificial Intelligence*, July 2023.

D. Lopresti, M. Turk, A. Schwartz, and C. Gill, *CCC's Response to RFI on Federal Video and Image Analytics Research and Development Action Plan*, September 2022.

REFEREED PUBLICATIONS and BOOKS:

P. Shukla, A. Chinchure, E. Diana, K. Hosanagar, A. Tolbert, and M. Turk, "Mitigate One, Skew Another? Tackling Intersectional Biases in Text-to-Image Models," *Findings of the Association for Computational Linguistics: EMNLP 2025*, November 2025.

C. Moore, C. Gill, N. Bliss, K. Butler, S. Forrest, D. Lopresti, M.L. Maher, H. Mentis, S. Shekhar, A. Stent, and M. Turk, "Concerning the Responsible Use of AI in the U.S. Criminal Justice System," *Communications of the ACM*, September 2025.

A. Chinchure, P. Shukla, G. Bhatt, K. Salij, K. Hosanagar, L. Sigal, and M. Turk, "TIBET: Identifying and Evaluating Biases in Text-to-Image Generative Models," *European Conference on Computer Vision (ECCV)*, October 2024.

Md. A. R. Ahad, U. Mahbub, M. Turk, and R. Hartley (editors), *Computer Vision: Challenges, Trends, and Opportunities*, Chapman and Hall / CRC Press, 2024.

Y. Gizatdinova, O. Špakov, O. Tuisku, M. Turk, and V. Surakka, "Vision-based interfaces for character-based text entry: comparison of errors and error correction properties of eye typing and head typing," *Advances in Human-Computer Interaction*, Hindawi, June 2023.

P. Shukla, S. Bharati, and M. Turk, "CAVLI – Using image associations to produce local concept-based explanations," *CVPR Workshop on Explainable AI for Computer Vision (XAI4CV)*, June 2023.

E.R. Davies and M. Turk (editors), *Advanced Methods and Deep Learning in Computer Vision*, Elsevier 2021.

J. Robinson, C. Qin, M. Shao, M. Turk, R. Chellappa, and Y. Fu, "Recognizing Families In the Wild

(RFIW): The 5th Edition,” IEEE Conference on Automatic Face and Gesture Recognition, December 2021.

J. Kozerawski, V. Fragoso, N. Karianakis, G. Mittal, M. Turk, and M. Chen, “BLT: Balancing Long-Tailed Datasets with Adversarially-Perturbed Images,” Asian Conference on Computer Vision (ACCV), Nov-Dec 2020.

J. Robinson, Y. Yin, Z. Khan, M. Shao, S. Xia, M. Stopa, S. Timoner, M. Turk, R. Chellappa, and Y. Fu, “Recognizing Families In the Wild (RFIW): The 4th Edition,” IEEE Conference on Automatic Face and Gesture Recognition, November 2020. M. Turk and V. Athitsos, “Gesture recognition,” in *Computer Vision: A Reference Guide*, Springer 2019.

Y. Ding, B. Huynh, A. Xu, T. Bullock, H. Cecotti, M. Turk, B. Giesbrecht, and T. Höllerer, “Multimodal classification of EEG during physical activity,” International Conference on Multimodal Interfaces (ICMI), Suzhou, China, October 2019.

P. Shukla, C. Elmadjian, R. Sharan, V. Kulkarni, M. Turk, and W. Y. Wang, “What should I ask? Using conversationally informative rewards for goal-oriented visual dialog,” Association for Computational Linguistics (ACL), Florence, Italy, July-August 2019.

B. Nuernberger, T. Höllerer, and M. Turk, “Hybrid orbiting-to-photos in 3D reconstructed visual reality,” ACM Symposium on Virtual Reality Software and Technology (VRST), Tokyo, Japan, November 2018.

I. Rakkolainen, R. Raisamo, M. Turk, and T. Höllerer, “Illumination for 360 degree cameras” (poster), ACM Symposium on Virtual Reality Software and Technology (VRST), Tokyo, Japan, November 2018.

Y. Gizatdinova, O. Špakov, O. Tuisku, M. Turk, and V. Surakka, “Gaze and head pointing for hands-free text entry: applicability to ultra-small virtual keyboards,” ACM Symposium on Eye Tracking Research & Applications (ETRA), Warsaw, Poland, June 2018.

P. Shukla, H. Sadana, A. Bansal, D. Verma, C. Elmadjian, B. Raman, and M. Turk, “Automatic cricket highlight generation using event-driven and excitement-based features,” 4th International Workshop on Computer Vision in Sports (CVsports), Salt Lake City, June 2018.

J. Kozerawski and M. Turk, “CLEAR: Cumulative LEARning for One-Shot One-Class Image Recognition,” IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), Salt Lake City, June 2018.

B. Nuernberger, M. Turk, and T. Höllerer, “Evaluating snapping-to-photos virtual travel interfaces for 3D reconstructed visual reality,” ACM Symposium on Virtual Reality Software and Technology (VRST), Gothenburg, Sweden, November 2017.

V. Fragoso, C. Sweeney, P. Sen, and M. Turk, “ANSAC: Adaptive Non-Minimal Sample and Consensus,” British Machine Vision Conference (BMVC), London, September 2017.

I. Rakkolainen, R. Raisamo, M. Turk, and T. Höllerer, “Field-of-View Extension for VR Viewers,” Mindtrek 2017: 21th International Technology Conference, Tampere, Finland, September 2017.

D. Baričević, T. Höllerer, P. Sen, and M. Turk, “User-perspective AR magic lens from gradient-based IBR and semi-dense stereo,” IEEE Transactions on Visualization and Computer Graphics, Vol. 23, Issue 7, pp. 1838-1851, 2017.

I. Rakkolainen, R. Raisamo, M. Turk, and T. Höllerer, “Extreme field-of-view for head-mounted displays,” 3DTV Conference (3DTV-CON), Copenhagen, Denmark, June 2017.

D. Baričević, T. Höllerer, and M. Turk, “Densification of semi-dense reconstructions for novel view

generation of live scenes,” IEEE Winter Conference on Applications of Computer Vision (WACV), Santa Rosa, CA, March 2017.

I. Rakkolainen, M. Turk, and T. Höllerer, “A superwide-FOV optical design for head-mounted displays,” International Conference on Artificial Reality and Telexistence / European Symposium on Virtual Environments (ICAT-EGVE), Little Rock, AR, December 2016.

D. Baričević, T. Höllerer, P. Sen, and M. Turk, “User-perspective AR magic lens from gradient-based IBR and semi-dense stereo,” IEEE Transactions on Visualization and Computer Graphics, Vol. 23, Issue 7, pp. 1838-1851, 2017.

V. Fragoso, W. Scheirer, J. Hespanha, and M. Turk, “One-class slab support vector machine,” International Conference on Pattern Recognition, Cancun, Mexico, December 2016.

I. Rakkolainen, M. Turk, and T. Höllerer, “A compact, wide-FOV optical design for head-mounted displays,” ACM Symposium on Virtual Reality Software and Technology (VRST), Munich, Germany, November 2016.

B. Nuernberger, K.-C. Lien, L. Grinta, C. Sweeney, M. Turk, and T. Höllerer, “Multi-view gesture annotations in image-based 3D reconstructed scenes,” ACM Symposium on Virtual Reality Software and Technology (VRST), Munich, Germany, November 2016.

C. Sweeney, V. Fragoso, M. Turk and T. Höllerer, “Large scale SfM with the distributed camera model,” International Conference on 3D Vision (3DV), Stanford, CA, October 2016.

I. Rakkolainen, R. Raisamo, M. Turk, and T. Höllerer, “Casual immersive viewing with smartphones,” Mindtrek 2016: 20th International Technology Conference, Tampere, Finland, October 2016.

K. Lien, B. Nuernberger, M. Turk, and T. Höllerer, “PPV: pixel-point-volume segmentation for object referencing in collaborative augmented reality,” IEEE International Symposium on Mixed and Augmented Reality (ISMAR), Merida, Mexico, September 2016.

X. Zhao, M. Turk, W. Li, and K. Lien, “A multilevel image thresholding segmentation algorithm based on two-dimensional K-L divergence and modified particle swarm optimization,” Applied Soft Computing, Vol. 48, pp. 151-159, 2016.

B. Nuernberger, K. Lien, M. Turk and T. Höllerer, “Anchoring 2D gesture annotations in augmented reality,” IEEE Virtual Reality (VR 2016), Greenville, SC, March 2016.

B. Nuernberger, K. Lien, M. Turk and T. Höllerer, “Interpreting 2D gesture annotations in 3D augmented reality,” IEEE Symposium on 3D User Interfaces (3DUI 2016), Greenville, SC, March 2016. (Best Paper Honorable Mention)

M. Turk and V. Fragoso, “Computer vision for mobile augmented reality,” in G. Hua and X.-S. Hua (eds.), Mobile Cloud Visual Media Computing, Springer International Publishing, 2015.

C. Sweeney, T. Sattler, M. Turk, T. Höllerer, and M. Pollefeys, “Optimizing the viewing graph for structure-from-motion,” International Conference on Computer Vision, Santiago, Chile, December 2015.

Y. Qin, K. Lien, M. Turk, and T. Höllerer, “Eye gaze correction with a single webcam based on eye-replacement,” 11th International Symposium on Visual Computing, Las Vegas, NV, December 2015.

- C. Sweeney, T. Höllerer, and M. Turk, “Theia: a fast and scalable structure-from-motion library,” ACM Conference on Multimedia, Brisbane, Australia, October 2015.
- C. Sweeney, J. Flynn, B. Nuernberger, M. Turk, and T. Höllerer, “Efficient computation of absolute pose for gravity-aware augmented reality,” IEEE International Symposium on Mixed and Augmented Reality (ISMAR), Fukuoka, Japan, October 2015. (Best Short Paper Award)
- K. Lien, B. Nuernberger, M. Turk, and T. Höllerer, “2D-3D co-segmentation for AR-based remote collaboration” (poster), IEEE International Symposium on Mixed and Augmented Reality (ISMAR), Fukuoka, Japan, October 2015.
- K. Lien and M. Turk, “On preserving structure in stereo seam carving,” IEEE International Conference on 3D Vision (3DV), Lyon, France, October 2015.
- A. A. Salah, H. Hung, O. Aran, H. Gunes, and M. Turk, “Behavior understanding for arts and entertainment,” ACM Transactions on Interactive Intelligent Systems Vol. 5, No. 3, September 2015.
- K. Lien, J. Gibson, and M. Turk, “High-order regularization for stereo color editing,” IEEE International Conference on Image Processing (ICIP), Québec City, Canada, September 2015.
- A. A. Salah, H. Hung, O. Aran, H. Gunes, and M. Turk, “Brief Introduction to the Special Issue on Behavior understanding for arts and entertainment,” ACM Transactions on Interactive Intelligent Systems Vol. 5, No. 2, July 2015.
- C. Sweeney, L. Kneip, T. Höllerer, and M. Turk, “Computing similarity transformations from only image correspondences,” IEEE Conference on Computer Vision and Pattern Recognition, Boston, MA, June 2015.
- N. Moreno, J. Cornick, S. Savage, M. Turk, A. Leal, and T. Höllerer, “Motivating crowds to volunteer neighborhood data,” ACM Conference on Computer-Supported Cooperative Work (CSCW), Vancouver, CA, March 2015.
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