

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

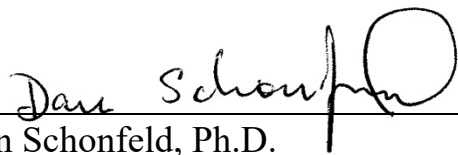
MAXELL, LTD.,
Patent Owner

Inter Partes Review No.: IPR2025-01312

**DECLARATION OF DR. DAN SCHONFELD IN SUPPORT OF
PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 7,952,645**

I hereby declare under penalty of perjury under the laws of the United States of America that the following is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I understand that willful false statements are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code.

Date: August 29, 2025



Dan Schonfeld, Ph.D.

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EXHIBITS

Exhibit No.	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. Jun. 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. Jul. 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.).

TABLE OF CLAIMS

[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;
[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.i] 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,
[5.e.ii] 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,
[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.

I. INTRODUCTION

1. I, Dr. Dan Schonfeld, have been retained by counsel for Petitioners Samsung Electronics Co. Ltd. and Samsung Electronics America, Inc. (collectively, “Samsung”) as an expert witness in this *inter partes* review. I have been asked to provide my opinion about the patentability of the claims of U.S. Patent No. 7,952,645 (the “’645 patent,” EX1001).

2. I have been retained at my normal hourly rate of \$800 per hour. My compensation is not contingent upon my performance, the outcome of this matter, or any issues involved in or related to this matter.

3. In summary, it is my opinion that the prior art references that I analyze below render obvious the ’645 patent’s claims, as summarized in the table below.

Ground	Claims	Statutory Basis	Prior Art Reference(s)
1	1-3	35 U.S.C. § 103	Kim
2	1-4	35 U.S.C. § 103	Fujimura
3	5-8	35 U.S.C. § 103	Fujimura and Kim

A. Background and Qualifications

4. The following is a summary of my relevant qualifications and professional experience.

5. I received my B.S. degree in Electrical Engineering and Computer Science from the University of California, Berkeley, in 1986 with a concentration on Computer Engineering/Systems Engineering. I received my M.S. degree in

Electrical and Computer Engineering from The Johns Hopkins University in Baltimore, Maryland in 1988 with a concentration on Speech Processing/Biomedical Signal Processing. I received my Ph.D. degree in Electrical and Computer Engineering from The Johns Hopkins University in Baltimore, Maryland in 1990 with a concentration on Nonlinear Signal Processing/Image Analysis.

6. In August 1990, I joined the Department of Electrical Engineering and Computer Science at the University of Illinois, Chicago, where I am a Professor Emeritus in the Departments of Electrical and Computer Engineering, Computer Science, and Biomedical Engineering. Before I joined the University of Illinois at Chicago, I served as an instructor in the Department of Electrical and Computer Engineering at The Johns Hopkins University in Baltimore, Maryland.

7. At the University of Illinois at Chicago, I have served as the Director of the University-Industry Engineering Research Center (UIERC), formerly the Manufacturing Research Center (MRC). I am also Co-Director of the Multimedia Communications Laboratory (MCL) and a member of the Signal and Image Research Laboratory (SIRL).

8. Over the past few decades, I have also served as a visiting professor in (a) the Advanced Analytics Institute (AAI) at the University of Technology in Sydney, Australia, (b) the Department of Information Engineering and Computer

Science (DISI) at the University of Trento, Italy, (c) the School of Computer Engineering at the Nanyang Technological University in Singapore, and (d) the Department of Electrical Engineering—Systems at Tel-Aviv University in Israel.

9. I have been elected Fellow of the Institute of Electrical and Electronics Engineers (IEEE) “for contributions to image and video analysis” as well as Fellow of the International Society for Optics and Photonics (“SPIE”) “for specific achievements in morphological image processing and video analysis.” I have also been elected University Scholar of the University of Illinois.

10. I have previously served as Editor-in-Chief and Deputy Editor-in-Chief of the IEEE Transactions on Circuits and Systems for Video Technology. I have also previously served as Area Editor for special issues of the IEEE Signal Processing Magazine. I have served as Associate Editor of the IEEE Transactions on Image Processing (on image and video storage, retrieval and analysis), Associate Editor of the IEEE Transactions on Circuits and Systems for Video Technology (on video analysis), Associate Editor of the IEEE Transactions on Signal Processing (on multidimensional signal processing and multimedia signal processing), and Associate Editor of the IEEE Transactions on Image Processing (on nonlinear filtering). I have also served on the editorial board of the IEEE Signal Processing Magazine, EURASIP Journal of Image and Video Processing, Research Letters in Signal Processing, and Bentham Science Publishers, Ltd.’s

“Recent Patents on Computer Science” and “Recent Patents on Electrical Engineering” publications. I have served as guest editor of numerous special issues in various journal publications in the area of multimedia systems.

11. I have previously served on the Conference Board of the IEEE Signal Processing Society. I have previously served as Technical Program Chair of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2018 as well as Program Chair of the IEEE Conference on Visual Communications and Image Processing (VCIP) 2015. I have also previously served as General Co-Chair of the Workshop on Big Data in 3D Computer Vision 2013 and the IEEE International Conference on Multimedia and Expo (ICME) 2012. I have served as Chair of the IEEE Workshop on Video Mining 2008 and the SPIE Conference on Visual Communications and Image Processing 2007. I have also served on the organizing committees of various conferences including the IEEE International Conference on Image Processing 1998, 2012, and 2020, IEEE/SPIE VCIP 2010, 2017, and IEEE Workshop on Nonlinear Signal and Image Processing (NSIP) 1997. I was an organizer of the Thematic Symposium on Multimedia Search and Retrieval at ICASSP 2009.

12. I have authored and co-authored over 250 technical papers for various journals and conferences. I was author of a book chapter, entitled: “Image and video communication networks,” and later editions entitled: “Video

communication networks.” I was co-author (with Carlo Giulietti and Rashid Ansari) of a paper that won the Best Paper Award at the ACM Multimedia Workshop on Advanced Video Streaming Techniques for Peer-to-Peer Networks and Social Networking 2010. I was also co-author (with Junlan Yang) of a paper that won the Best Student Paper Award at the IEEE International Conference on Image Processing 2007. I was also co-author (with Wei Qu) of a paper that won the Best Student Paper Award at the IEEE International Conference on Image Processing 2006. I was also co-author (with Nidhal Bouaynaya) of a paper that won the Best Student Paper Award in Visual Communications and Image Processing 2006. In addition, many of my publications relate to the broad topic of multimedia systems, which includes audio, image, and video processing. My publications in the area of multimedia systems date back to 1988.

13. I have been selected to be the keynote speaker at the IEEE International Conference on Computer, Electrical and Communication Engineering (ICCECE), Kolkata, India, in 2023. I was also the keynote speaker at the International Conference on Wireless Communications and Signal Processing (WCSP), Yangzhou, China, in 2016, and the International Conference on Intelligent Control and Information Processing (ICICIP) and International Conference on Brain Inspired Cognitive Systems (BICS), Beijing, China, in 2013. Further, I was a plenary speaker at the IEEE/IET International Conference on

Audio, Language and Image Processing (ICALIP), Shanghai, China, in 2010, and at the IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS), Genoa, Italy, in 2009. I was also a plenary speaker at the INPT/ASME International Conference on Communications, Signals, and Systems (ICCSS), Rabat Morocco, in 1995 and 2001.

14. I have served as Representative of Regions 1-6 (North America) on the Chapters Committee of the IEEE Signal Processing Society. I have also served as Chairman of the IEEE Signal Processing Chicago Chapter. I have also served on the IEEE Image, Video, and Multidimensional Signal Processing (IVMSP) Technical Committee, formerly the IEEE Image and Multidimensional Signal Processing (IMDSP) Technical Committee, Visual Signal Processing and Communications (VSPC) Technical Committee, IEEE Signal and Image Processing in Medicine Technical Committee, and the IEEE Multimedia Communications Technical Committee. I currently serve on the American National Standards Institute (ANSI)/Underwriters Laboratory (UL) Standards Technical Panel ("STP") on Multimedia Systems.

15. Since the late 1990s, I have also taught various courses that relate to multimedia systems. For example, I have introduced and taught an advanced undergraduate-level/first-year graduate-level course on multimedia systems (originally called multimedia communication networks), which focuses on audio,

image, and video processing and communications.

16. I have also served as a consultant in various engagements related to multimedia systems. For example, over the past decade, I have served as an expert witness in several cases related to multimedia systems. In 1997, I served as a consultant for Prairiecomm Corp. where, among other tasks, I developed and deployed multimedia systems. Since 2002, I have also served as a member of the American National Standards Institute (ANSI)/Underwriters Laboratory (UL) Standards Technical Panel (STP) on various standards related to multimedia systems.

17. My qualifications, publications, professional experience and expertise are set forth more fully in my curriculum vitae, attached as Appendix A.

B. Materials Considered

18. In preparing this Declaration and forming my opinions, I have considered the materials referenced in this Declaration, including in the table of exhibits at the beginning of this Declaration. My opinions also are based on my years of education, research, and experience, as well as my review of relevant materials.

II. LEGAL STANDARDS

A. Date of Invention

19. I have been asked to use the date of the earliest application to which the '645 patent claims priority (November 24, 2005) as the date of the purported

invention for purposes of my analysis.

B. Anticipation

20. I understand from counsel that a patent claim is invalid under 35 U.S.C. § 102 if a prior art disclosure teaches every element required by the claim, either expressly or inherently. The identical invention must be shown in as complete detail as is contained in the claim. When a claim covers several structures or compositions, either generically or as alternatives, the claim is deemed anticipated if any of the structures or compositions within the scope of the claim is known in the prior art.

C. Obviousness

21. I understand from counsel that a patent claim is invalid under 35 U.S.C. § 103 if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention to a person having ordinary skill in the art to which the subject matter pertains. Obviousness, as has been explained to me, is based on (i) the scope and content of the prior art, (ii) the differences between the prior art and the claim, (iii) the level of ordinary skill in the art, and (iv) any secondary indicia of non-obviousness (e.g., “secondary considerations” such as commercial success in the market place of the claimed invention), to the extent that they exist.

22. I further understand from counsel that obviousness may be

demonstrated by showing that it would have been obvious to combine the teachings of more than one item of prior art. In determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of a person having ordinary skill in the art, the following are examples of approaches and rationales that may be considered:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of a known technique to improve similar devices (methods, or products) in the same way;
- Applying a known technique to a known device (method or product) ready for improvement to yield predictable results;
- Applying a technique or approach that would have been obvious to try (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to a person having ordinary skill in the art; and
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

23. I further understand that an invention may be obvious if one of ordinary skill in the art, facing a wide range of needs created by developments in

the field, would have seen an obvious benefit to the solutions tried by the applicant. When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, it may be obvious to a person of ordinary skill to try the known options. If a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique would have been obvious.

24. I further understand that a person of ordinary skill in the art is a hypothetical person who is presumed to be aware of all of the relevant art at the time of the invention. The person of ordinary skill may be able to fit together the teachings of multiple patents and/or printed publications employing ordinary creativity and the common sense that familiar items may have uses in another context or beyond their primary purposes.

25. I also understand that when considering the obviousness of a patent claim, one should consider whether a teaching, suggestion, or motivation to combine the references exists so as to avoid impermissibly applying hindsight when combining or modifying the prior art. I understand this test should not be applied rigidly, but that the test can be important to avoid such hindsight.

26. I also understand that one of ordinary skill in the art must have a reasonable expectation of success in combining or modifying prior art references.

27. I also understand that all elements of a claim must be considered in an obviousness analysis.

D. Standard of Proof

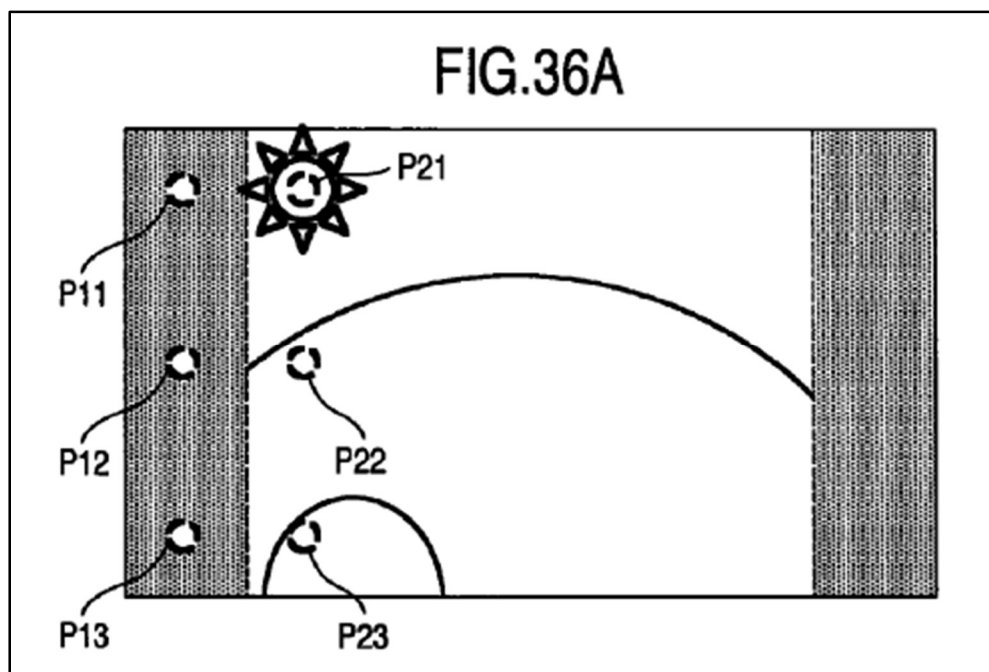
28. I understand that the standard to prove unpatentability in an *inter partes* review is by a preponderance of the evidence, which means more likely than not.

III. THE '645 PATENT

A. Summary of the '645 Patent

29. The '645 patent issued from U.S. Patent Application No. 11/602,956, filed November 22, 2006, and it claims priority to Japanese Patent Application No. 2005-338000, filed on November 24, 2005. EX1001, cover page. The '645 patent's earliest possible effective filing date therefore is November 24, 2005.

30. The '645 patent relates to a "video processing apparatus" that "corrects [a] video signal." EX1001, Abstract, 1:60-65. The patent states that, when converting a video signal with an aspect ratio of 4:3 to a video signal with an aspect ratio of 16:9 (for display on a screen with such an aspect ratio), "wallpapers are added to the left and right of the contents." *Id.*, 1:41-45, 16:7-12. The "wallpapers" may be "black no-picture areas." *Id.*, 1:41-45, 1:51-54. The patent's Figure 36A, shown below, shows an example of such a video signal.



Id., 19:26-30; *see also id.*, Fig. 29 (same), 16:57-17:1.

31. The patent states that, when performing “picture quality correction,” “the luminance and colors of the wallpaper portions are changed,” which may make the video “rather hard to watch.” EX1001, 1:45-50. Also, “black no-picture areas” prevent the “average values of luminance and color of the 4:3 contents themselves” from being “calculated accurately.” *Id.*, 1:51-56, 16:16-21. Accordingly, the patent describes detecting whether the video signal includes “pattern portions,” such as “wallpaper portions having a pattern or the like or no-picture area portions having a single color.” *Id.*, Abstract, 1:60-65, 16:21-25.

32. In the patent’s “third embodiment,” if the apparatus detects that the video signal includes “pattern portions,” it does not correct the video signal. EX1001, 1:65-67, 16:21-25, 19:58-63, Fig. 34, 18:50-61 (when there is a pattern

portion, correction data is set to zero).

33. Further, when “the pattern portions are formed of single color of black,” correction causes less of a change in the pattern portion compared to when the pattern portions “are formed of patterns or a single chromatic color.” EX1001, 20:14-17. In the patent’s “fourth embodiment,” the apparatus detects whether the pattern portions are “black no-picture areas.” *Id.*, 20:17-20. If they are, the video signal is corrected. *Id.*, 20:20-22, Fig. 44, 23:4-12 (steps 4402 and 4405). If the pattern portions are “not a black no-picture area portion,” the video signal is not corrected. *Id.*, 20:22-25, Fig. 44 (steps 4401 and 4403).

B. Summary of the ’645 Patent’s File History

34. The United States Patent and Trademark Office (“USPTO”) issued the ’645 patent on May 31, 2011, without having rejected the claims during prosecution. EX1002, 2. In the Examiner’s reasons for allowance, the Examiner stated that “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.” *Id.*, 21.

C. A Person of Ordinary Skill in the Art

35. In my opinion, a person of ordinary skill in the art (“POSITA”) at the time of the alleged invention of the ’645 patent (November 24, 2005) would have

had a bachelor's degree in computer science, electrical engineering, 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. Additional education could substitute for professional experience, and significant industry experience could substitute for formal education.

36. I met and exceeded the above qualifications for a POSITA as of at least November 24, 2005, and consider myself to be at least a POSITA of the '645 patent.

D. Patent Owner's Infringement Contentions

37. I have reviewed Patent Owner Maxell, Ltd.'s ("Patent Owner") infringement contentions for the '645 patent in the litigation between Patent Owner and Samsung. EX1013, pp. 57-64; EX1014.

IV. CLAIM CONSTRUCTION

38. In this section, I address the construction of certain claim terms, and I have applied those constructions in my analysis. For all other terms, I have applied the plain and ordinary meaning as understood by a POSITA at the time of the purported invention.

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

39. In my opinion, the plain and ordinary meaning of "video signal" includes a logical unit of video.

40. This interpretation is confirmed by the '645 patent specification, which discloses operating on logical “unit[s]” of video such as a “frame” and a “scene.” EX1001, 6:67-7:5 (“taking a frame as the unit”), 7:61-65 (same), 8:25-29 (same), 16:16-21 (“taking a frame as the unit or a scene as the unit”). This interpretation also is confirmed by, for example, the Chambers Dictionary of Science and Technology, which defines “signal” to include “a conveyor of information.” EX1007, 3.

41. A “video signal” may also be a series of frames, such as a movie, for the same reasons. The '645 patent confirms this interpretation. EX1001, 6:29-31 (the video contents can be “a drama, a movie, a sport or the like”), 6:24-27 (“a moving picture”), 12:39-42 (“video signal” includes a “number of frames”), 20:5-10 (“consecutive frames”), Fig. 35C (frames 1 and 2), Fig. 36C (same).

B. “a corrector which corrects the video signal input to the input unit” (claims 1 and 5) and “a corrector which changes correction characteristics according to a result of detection output from the characteristic point detector” (claim 3)

42. I understand from counsel that in litigation between Patent Owner and Lenovo regarding the '645 patent, Patent Owner argued that these claim elements are means-plus-function elements and that their corresponding structure is “CPU 7 or equivalents thereof.” EX1011 (responsive claim construction brief), 30-34; EX1012 (sur-reply claim construction brief), 16-17. If Patent Owner asserts in this IPR that these claim elements are means-plus-function claim elements, I

understand from counsel that the Board should dismiss any argument by Patent Owner that the structure is anything but “CPU 7 or equivalents thereof,” in light of Patent Owner’s previous arguments. *Id.*

43. In my analysis, I address both the plain meaning of these claim elements and a means-plus-function interpretation of these claim elements where the corresponding structure is “CPU 7 or equivalents thereof.”

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

44. In my opinion, a POSITA would have understood this claim element to include correcting *part of* the video signal.

45. I have been informed by counsel that the scope of a claim term should not be interpreted in a way that excludes an embodiment disclosed in the specification, unless there is “highly persuasive” evidence to the contrary. The ’645 patent’s specification describes embodiments in which only part of the video signal is corrected. For example, the patent’s Figure 21 shows “correction value[s]” of zero for certain “gradation areas” and non-zero correction values for other gradation areas. EX1001, Fig. 21, 13:38-49. Figures 23B and 23D likewise show correction to only certain gradation areas. EX1001, Figs. 23A-D, 14:3-30 (“the modulator 152 has corrected the output gradation relative to the input gradation in the range of 47 to 255”); *see also id.*, Figs. 24A-B, 14:53-67. I am not aware of any highly persuasive evidence, including in the ’645 patent and its file

history, that would warrant excluding these embodiments from the claims' scope.

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

46. In the context of the '645 patent, a POSITA would have understood the plain meaning of these claim elements to mean that the pattern portions are *included* in the video signal and the pattern portions are *not included* in the video signal, respectively. *See* EX1001, Abstract (“portions having a pattern ... are contained ... in a video signal;” “pattern portions are contained in the input video signal”), 1:60-67 (same), 19:58-61 (“it is detected whether the video signal includes a pattern portion. If a pattern portion is contained ...”), 24:26-28 (“pattern portions are contained above and below the image”).

47. Moreover, the full scope of these claim elements include a video signal with some frames that contain pattern portions and some frames that do not. As explained in Section IV.C, I understand from counsel that excluding a disclosed embodiment from a claim's scope requires “highly persuasive” evidentiary support. In the '645 patent's “third embodiment,” “enhancement processing” (correction) “is stopped” “at the time of display of [the] pattern portions.” EX1001, 19:52-57; *see also id.*, 19:59-61, 19:67-20:1 (“correction data may be stopped in response to the detection of the pattern portion”). In other words, the system was correcting the video signal but “stopped” upon detection of a pattern portion. *See also id.*, 18:62-19:25 (where the system determines the video frames

have no pattern portion, the system “finishes” (*i.e.*, completes) “the [enhancement processing]”, Figs. 35A-C, 19:26-57 (where the system determines the video frames have a pattern portion, enhancement processing is “stopped”), Figs. 36A-C. I am not aware of any highly persuasive evidence, including in the ’645 patent and its file history, that would warrant excluding this embodiment from the claims’ scope. A POSITA would have therefore understood that these claim elements include the video signal described above.

- 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)**

48. Patent Owner apparently construes “when” in these claim elements to be broader than “*whenever*,” and to be satisfied by *certain instances* in which “the pattern portions are contained,” “the pattern portions are not contained,” and “the pattern portions are not the no-picture areas,” respectively. Specifically, in the litigation between Patent Owner and Samsung, Patent Owner asserts infringement of claim 1 based on, for example, the selectable “Food mode” feature of a “Camera” app that “blur[s] the sides and background of your dish.” EX1013, 58. Because the Camera app blurs the sides and background of a photographed dish only when the user taps “FOOD,” Patent Owner apparently construes “when” in these claim elements as described above. *Id.* Likewise, Patent Owner also asserts infringement of claim 1 based on, for example, the selectable “Portrait mode”

feature of a Camera app that “blur[s] the background around the subject.” *Id.*, 59.

Because the Camera app does so only when the user taps “PORTRAIT,” Patent Owner again apparently construes “when” in these claim elements as described above. *Id.*; *see also id.*, 60 (also accusing “Portrait video”).

49. I have been asked by counsel to adopt this apparent construction for purposes of this IPR, and I have done so in my analysis.

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

50. In my opinion, a POSITA would have understood “characteristic point detector,” in light of the ’645 patent specification, to include a component that determines a histogram of luminance from an input video signal. The ’645 patent specification describes the “characteristic point detector” as “calculat[ing] characteristic data such as ... a histogram of the input video signal on the basis of the luminance signal Y” EX1001, 5:41-46, Fig. 5 (luminance characteristic point detector calculating a luminance histogram), 6:64-7:51, Fig. 6 (example luminance histogram), 7:52-58, 24:43-44 (the specification embodiments are preferred embodiments). There is no “highly persuasive” evidence, including in the ’645 patent and its file history, that warrants excluding this embodiment from the claims’ scope. *See* § IV.C. This description also is consistent with the claim language, which recites that the characteristic point detector “detects a level or distribution of at least one of luminance, hue and saturation of the video signal.”

EX1001, 24:65-67, 25:10-12, 26:14-16.

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

51. In my opinion, a POSITA would have understood 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. I have been informed by counsel of the last antecedent doctrine, which states that “a limiting clause or phrase ... should ordinarily be read as modifying only the noun or phrase that it immediately follows.” Therefore, “from the characteristic point detector” is presumed to modify only “detection output” and not also modify “a result of.” There is no evidence, including in the ’645 patent and its file history, that overcomes this presumption. In other words, the “result” does not have to be “from the characteristic point detector.”

H. “a corrector which changes correction characteristics according to a result of detection output from the characteristic point detector” (claim 3)

52. In my opinion, 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. There is no clear disavowal or contrary definition otherwise in the ’645 patent or its file history.

53. This interpretation also is consistent with dictionary definitions of “according to.” EX1008 (The New Oxford American Dictionary), 3 (defining “according to” to include “in a manner corresponding or conforming to”); EX1009 (Webster’s New College Dictionary), 3 (defining “according to” to include “in agreement with”); EX1010 (The Chambers Dictionary), 3 (defining “according to” to include “in accordance with”).

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

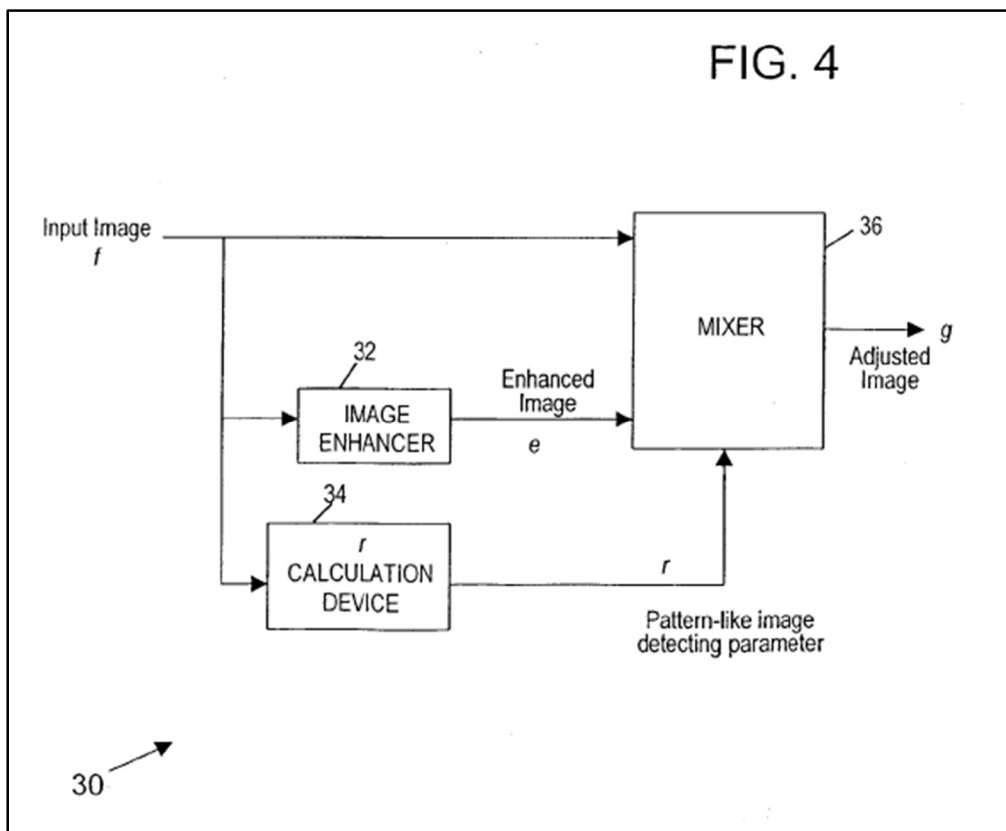
54. In my opinion, a POSITA would have understood that the claim language “not to change the correction characteristics ... when the pattern portions are contained” should be interpreted to include setting the correction characteristics to a value that is constant (*i.e.*, does not change) when “the pattern portions are contained.” The ’645 patent discloses embodiments where, “when there is a pattern portion, the CPU 7 sets correction data=‘0,’” a constant value. EX1001, 18:50-61, Fig. 34 (step 3403); *see also id.*, 22:63-23:3 (if a black no-picture area is contained in the pattern portion, set correction data to 0), Fig. 44 (step 4403). There is no “highly persuasive” evidence, including in the ’645 patent and its file history, that warrants excluding these embodiments from this claim’s scope. *See* Section IV.C. This claim element therefore includes setting the correction characteristics to a constant value such as zero.

V. SUMMARY OF THE PRIOR ART

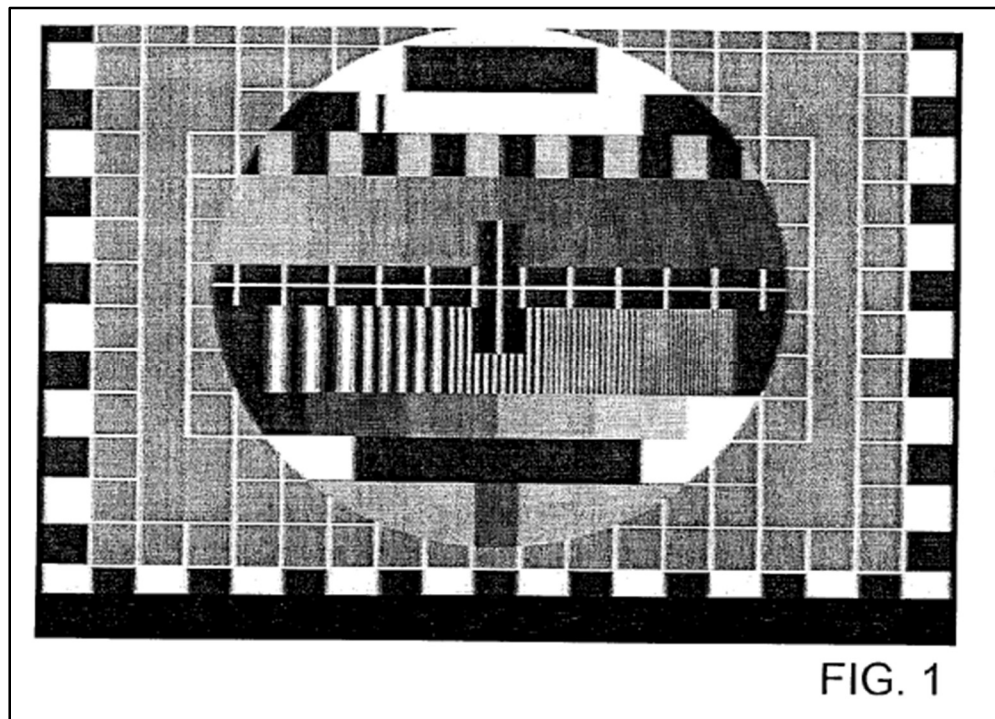
A. Kim

55. U.S. Patent Application Publication No. 2004/0156545 ("Kim") was filed on February 7, 2003, and published on August 12, 2004. EX1004, cover page. I understand that Kim therefore is prior art to the '645 patent under 35 U.S.C. §§ 102(a), (b), and (e) (pre-AIA).

56. Kim discloses a video processing system that performs, for example, contrast enhancement and color enhancement. Kim's Figure 4, shown below, is a block diagram of such a system.



EX1004, ¶41. Image enhancer 32 enhances image f from the video to produce enhanced image e. *Id.*, ¶¶40-41. The system calculates parameter r, which ranges from 0 to 1. *Id.*, ¶39. If r equals 1, the image input is determined to be “a pattern-like image.” *Id.*, ¶43. Kim’s Figure 1, shown below, shows an example of such an image. *Id.*, ¶1.



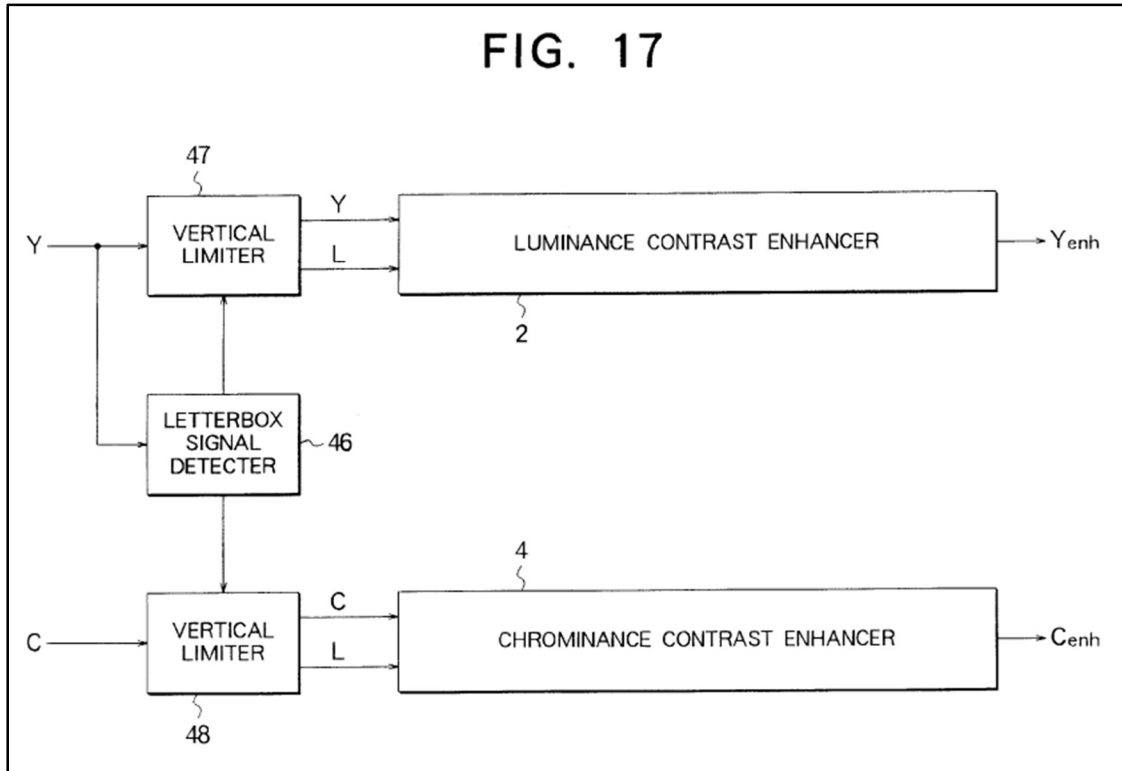
If the image is a pattern-like image, the system does not enhance the image. *Id.*, ¶43. Specifically, adjusted image g in Figure 4 is equal to image f. *Id.* If r equals 0, the image f is a normal image and is enhanced as normal. *Id.*, ¶¶39, 43. Specifically, adjusted image g in Figure 4 is the enhanced image e. *Id.*, ¶43. If r is between 0 and 1, adjusted image g is a proportional mix of image f and enhanced image e. *Id.*

57. Kim is analogous art to the '645 patent because it relates to video processing and adjusting image enhancement based on whether a video image is a pattern-like image, as described above. The USPTO did not consider Kim during prosecution of the '645 patent. EX1001, pp. 1-2.

B. Fujimura

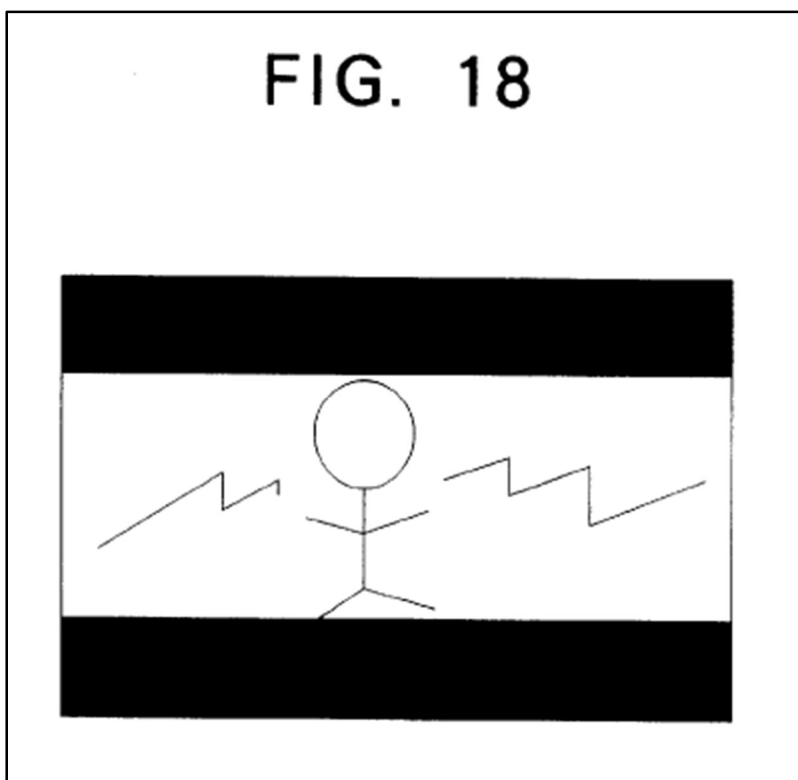
58. U.S. Patent No. 5,808,697 ("Fujimura") was filed on June 14, 1996, and issued on September 15, 1998. EX1005, cover page. I understand that Fujimura therefore is prior art to the '645 patent under 35 U.S.C. §§ 102(a), (b), and (e) (pre-AIA).

59. Fujimura discloses a video processing system that enhances luminance contrast and chrominance contrast. EX1005, Abstract, 1:3-6, 1:57-2:7, 3:63-64. The system separates an input video signal into a luminance signal Y and a chrominance signal C, and processes each independently. *Id.*, 4:16-18, 7:36-40, 8:12-16. Each embodiment includes luminance contrast enhancer 2 for the luminance signal and chrominance contrast enhancer 4 for the chrominance signal. *Id.*, Fig. 1 (first embodiment), Fig. 8 (second embodiment), Fig. 17 (fourth embodiment), 13:30-33 (the fourth embodiment includes the luminance contrast enhancer of either the first or second embodiments). Figure 17 is shown below.



Luminance contrast enhancer 2 enhances contrast by applying one or more mapping functions. *Id.*, 2:28-32, 4:41-49, 6:19-28, 9:30-35, 9:56-60, Figs. 3A-B.

60. The video and the luminance signal may include black bands above and below the picture area, as shown below in Figure 18, which is referred to as a “letterbox” layout. EX1005, 2:49-52, 13:42-49.



“[L]etterbox signal detector 46” determines whether the video is in letterbox format. *Id.*, 13:50-58, Fig. 17. It also determines the line numbers of the horizontal scanning lines of the top and bottom of the picture area. *Id.*, 13:53-58, 14:46-50. Vertical limiter 47 then limits the luminance contrast enhancement to the picture area. *Id.*, 14:46-59, Fig. 17.

61. Fujimura is analogous art to the '645 patent because it relates to video processing and accounting for the presence of certain patterns in the video when performing luminance correction, as described above. The USPTO did not consider Fujimura during prosecution of the '645 patent. EX1001, pp. 1-2.

VI. GROUND 1: CLAIMS 1-3 ARE OBVIOUS IN LIGHT OF KIM

62. As set forth in detail below, in my opinion, claims 1-3 are obvious in

light of Kim.

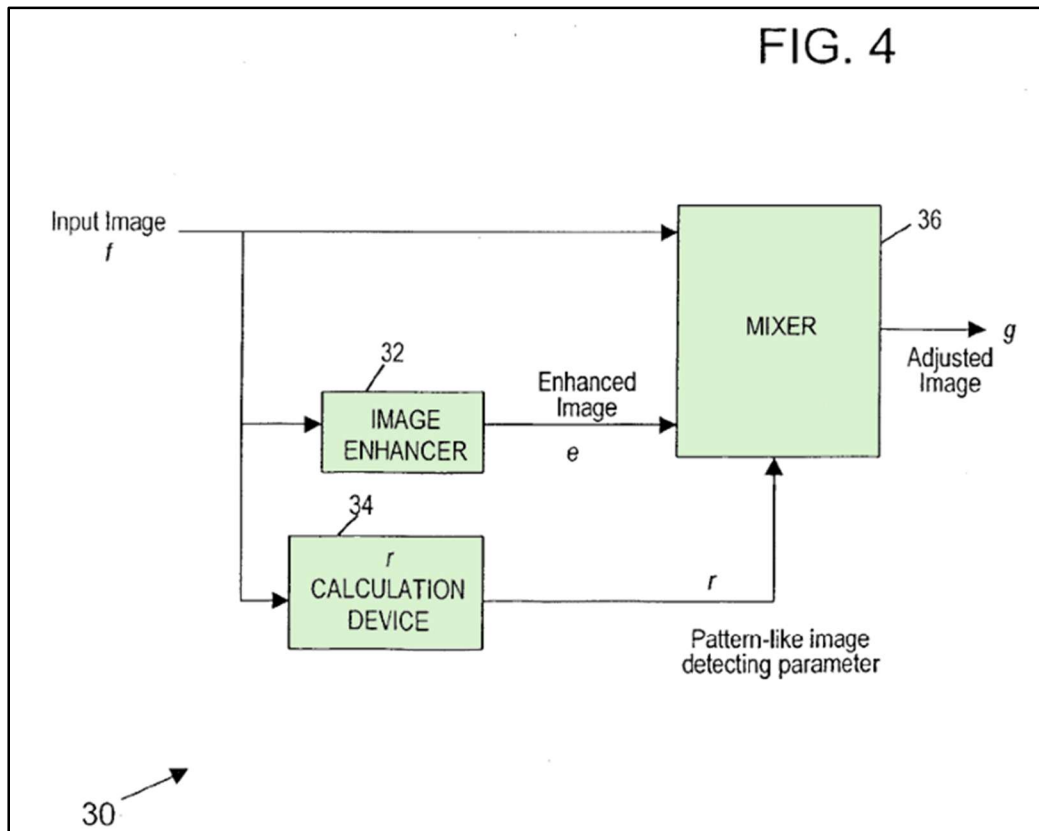
A. Claim 1

1. [1.pre] (“A video processing apparatus comprising:”)

63. Kim discloses this preamble. Kim discloses a “video enhancement system” that performs “video signal processing” (*a video processing apparatus*). EX1004, Abstract, ¶1. As described above, Kim’s Figure 4 shows such a system. *Id.*, ¶¶41-43. The “image f” in Figure 4 can be one frame of a video. *Id.*, ¶40 (“for the incoming video or image input, a histogram of one frame f of the picture”).

2. [1.a] (“an input unit to which a video signal containing contents is input;”)

64. Kim discloses this claim element. Kim discloses “image enhancement system” 30 (*an input unit*), annotated in green below in Figure 4:



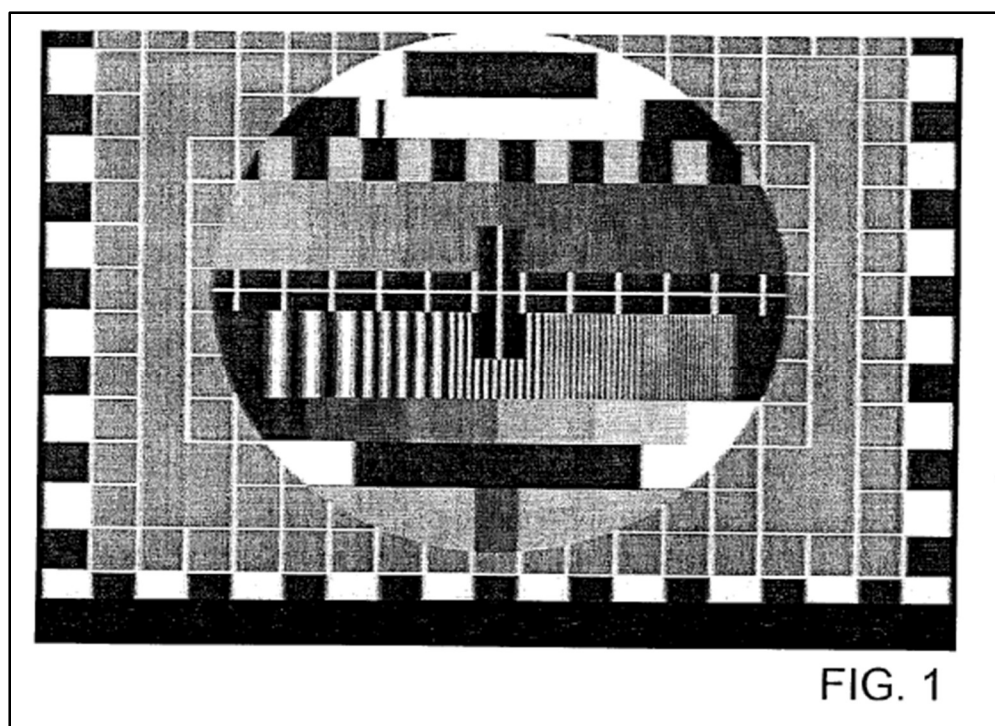
EX1004, ¶41. The system enhances an “incoming video” (*a video signal containing contents is input*). *Id.*, ¶40; *see also id.*, ¶1 (“video signal processing,” “video signal,” “video enhancement”); *see* §IV.A (construction of “video signal”). The system processes the “incoming video” one “frame” or “image” at a time. *Id.*, ¶40 (“one frame f”), ¶42 (“image f”), Fig. 4. The “incoming video” can *contain[] contents* such as “a normal image,” as opposed to a “pattern-like image.” *Id.*, ¶39, ¶1 (“normal images (not pattern-like images)”).

65. Alternately, each of image enhancer 32, calculation device 34, and mixer 36 individually also is an *input unit to which* the “incoming video” (*a video signal containing contents*) is *input* for the same reasons that system 30 is such an

input unit. Figure 4 shows that the video is *input* into each module, one “image f” at a time.

3. [1.b] (“a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit;”)

66. Kim discloses this claim element. Kim discloses that an “incoming video” is a *video signal input to the input unit*. See element 1.a. An image f from the video can include a “pattern-like image,” such as the “pattern-like image” shown in Figure 1 (*pattern portions ... in the video signal*). EX1004, ¶39, ¶1.

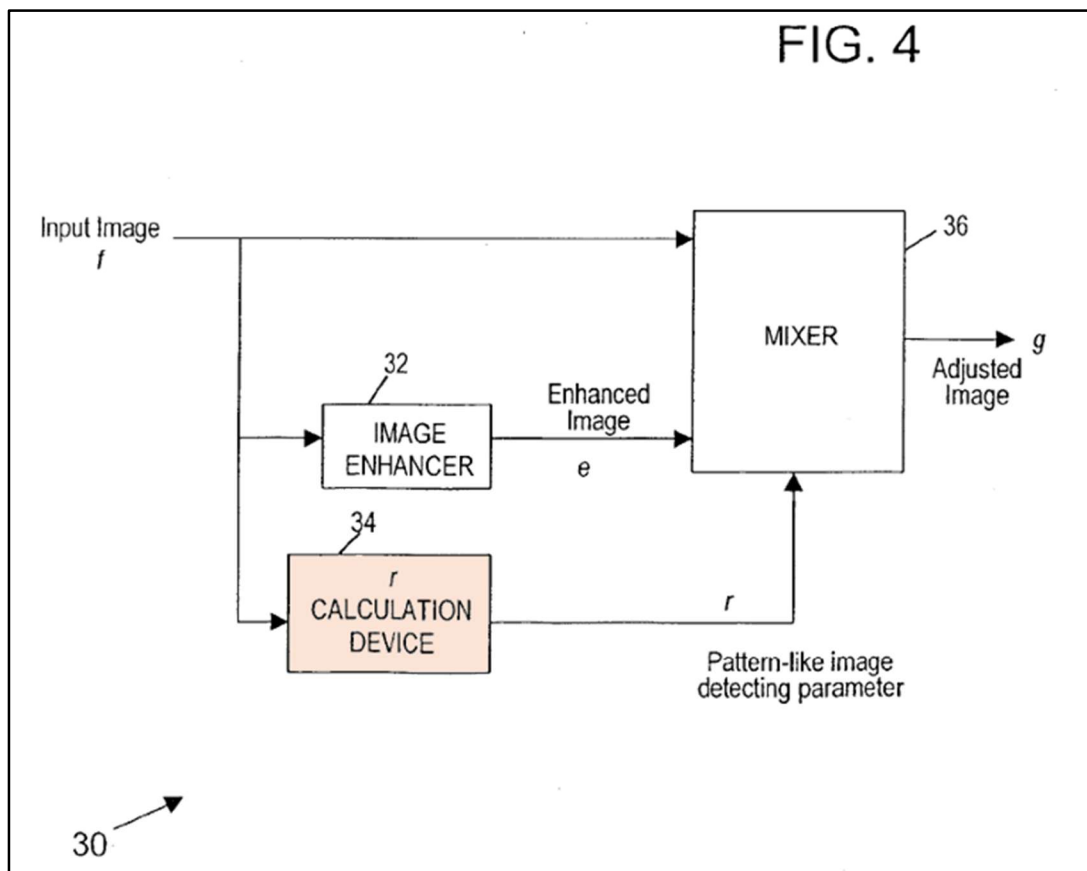


The pattern-like image is different than “a normal image,” and therefore is *pattern portions other than contents*. See element 1.a.

67. Kim also discloses “r calculation device 34” (*a detector*, annotated in

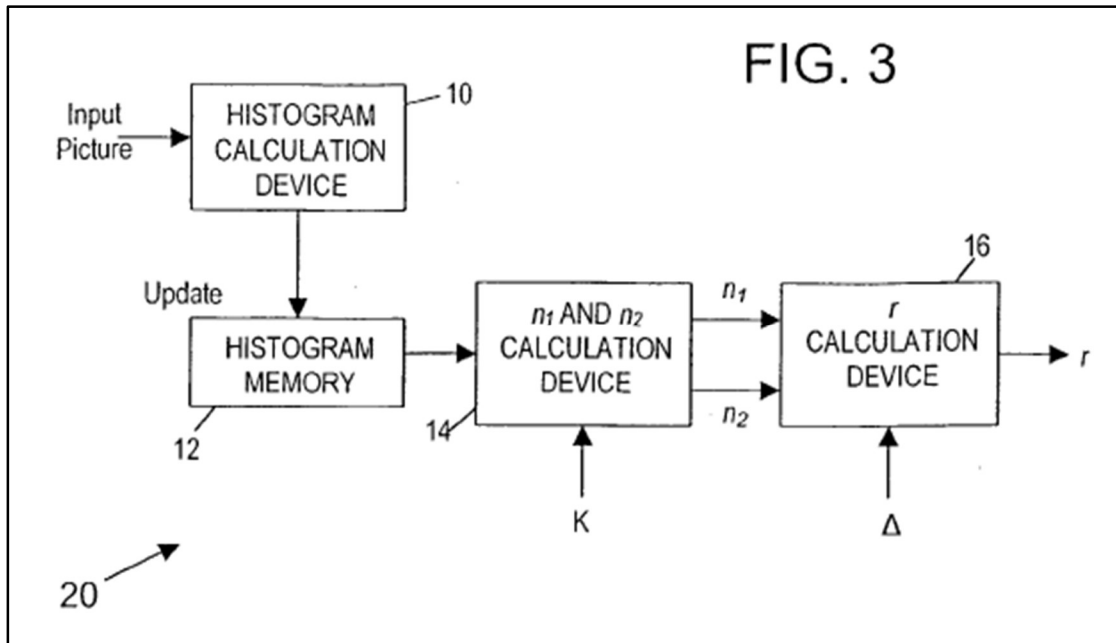
orange below) that calculates r , “a pattern-like image detection parameter.”

EX1004, ¶43, Fig. 4. The parameter r ranges from 0 to 1 and “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.” *Id.*, ¶39. Thus, when r equals 1, the image from the incoming video is “a pattern-like image.” *Id.*, ¶43. In that case, “ r calculation device 34” has detected that a pattern portion is included in image f , and therefore also is included in the incoming video (*whether pattern portions other than contents are contained in the video signal*).



68. Kim also discloses details of how r may be calculated, as shown

below in Figure 3.



Histogram calculation device 10 determines the histogram of frame f , and the histogram is stored in histogram memory 12. EX1004, ¶40. Calculation device 14 then calculates n_1 and n_2 , which represent the number of samples in the histogram that are greater than constant K and less than or equal to K , respectively. *Id.*, ¶40, ¶35, ¶¶26-31. Calculation device 16 finally calculates r using equation 5 or a similar equation. *Id.*, ¶40, ¶37 (equation 5), ¶36 (similar equations). Thus, apparatus 20 of Figure 3 also is the *detector* of this element for the same reasons that “ r calculation device 34” of Figure 4 is a *detector*. Thus, in my opinion, a POSITA also would have understood that “ r calculation device 34” of Figure 4 includes the functionality shown in Figure 3 because it calculates r . *Id.*, ¶43, Fig. 4.

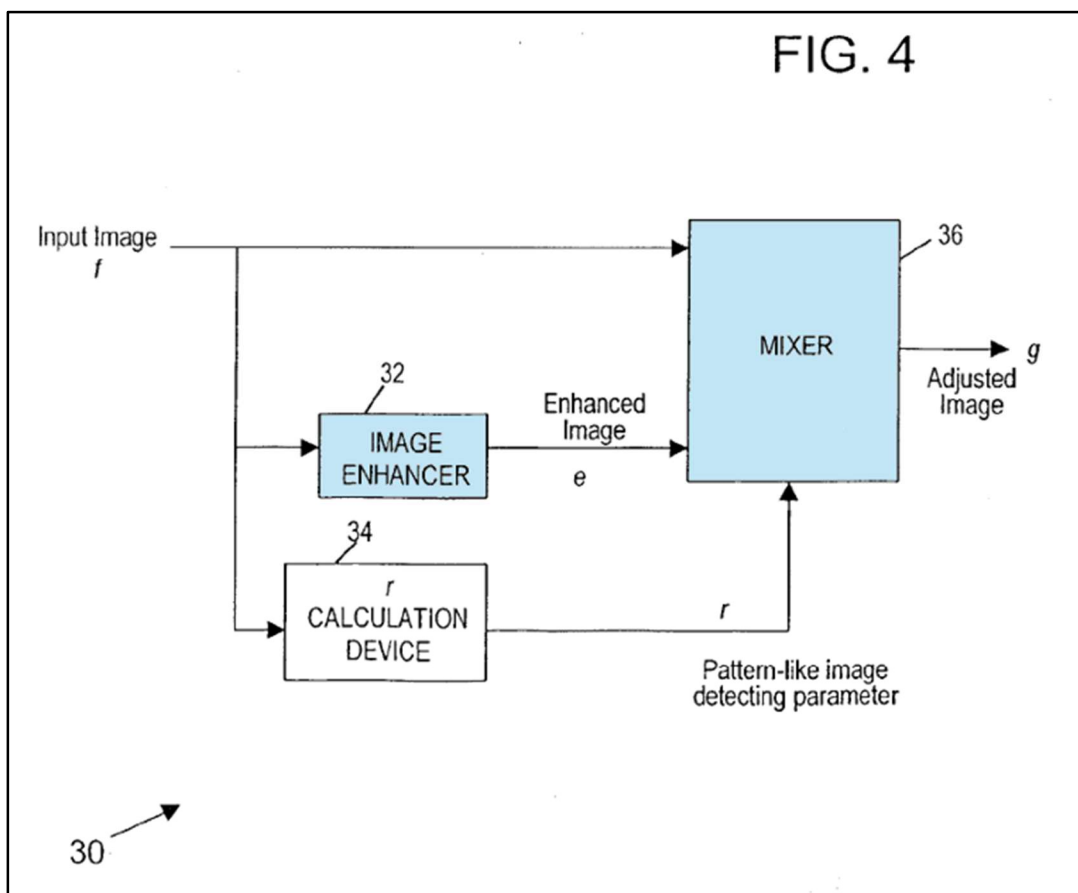
69. If Patent Owner argues that the recited *detector* must be separate from the *input unit* of element 1.a, such argument is incorrect. The claim recites these elements functionally rather than structurally, and nothing in the '645 patent or its file history prohibits the *detector* and the *input unit* from overlapping or from one being a subpart of the other.

70. If this claim element is construed as a means-plus-function claim element with corresponding structure of a CPU and its equivalents, Kim discloses this structure for the reasons set forth below for element 1.c. In my opinion, a POSITA would have understood that Kim implicitly and inherently discloses that the functions of “r calculation device 34” of Figure 4 are performed in a processor such as a CPU or equivalent, and it would have been obvious to a POSITA to implement these functions in a CPU or equivalent, for the reasons set forth for element 1.c.

4. [1.c] (“a corrector which corrects the video signal input to the input unit; and”)

71. Kim discloses this claim element. Kim discloses “image enhancer 32” that enhances image *f* using “any one of a number of known enhancement methods.” EX1004, ¶41, Fig. 4 (it outputs “Enhanced Image *e*”). Mixer 36 outputs an “adjusted image *g*” by “mix[ing] the input image *f* and the enhanced image *e* according to equation (6),” which is $g = r \cdot f + (1 - r) \cdot e$. *Id.*, ¶42, Fig. 4. In equation 6, if *r* equals 1, no enhancement is performed and the adjusted image *g*

output by mixer 36 is the image f . *Id.*, ¶43. If r equals 0, the adjusted image g is the enhanced image e . *Id.* If r is between 0 and 1, the adjusted image g is a proportional mix of image f and enhanced image e . *Id.* Image enhancer 32 and mixer 36 (annotated in blue below) collectively therefore are a *corrector* that *corrects* image f from the “incoming video” (*the video signal input to the input unit*). See §IV.C (construction of “corrects the video signal”).



72. In addition, mixer 36 by itself also is a *corrector* that *corrects* image f from the “incoming video” (*the video signal*) because it receives image f from the video and outputs adjusted image g , which has a level of correction that is

inversely related to r , as described above.

73. If Patent Owner argues that the recited *corrector* must be separate from the *input unit* of element 1.a, this argument is incorrect. The claim recites these elements functionally rather than structurally, and nothing in the '645 patent or its file history prohibits them from overlapping or from one being a subpart of the other.

74. If Patent Owner argues that this claim element is a means-plus-function claim element, Kim discloses Patent Owner's proposed corresponding structure from litigation ("CPU 7 or equivalents thereof"). See §IV.B. In my opinion, a POSITA would have understood that Kim implicitly discloses that the functions of the "image enhancement system" of Figure 4, including the functions of image enhancer 32 and mixer 36, are performed in a processor such as a CPU or equivalent. EX1004, ¶41. A POSITA would have further understood that the disclosed functionality is performed by executing instructions in a general-purpose processor such as a CPU or equivalent, or performed by a hardware equivalent to such a CPU, because such a component would be required to implement the disclosed functionality. Kim also inherently (necessarily) discloses a processor such as a CPU or equivalent for the same reasons. 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. Such a CPU would have

been well-known to a POSITA. *E.g.*, EX1005 (Fujimura), 4:6-11 (image processing system can be implemented in a “general-purpose processor”).

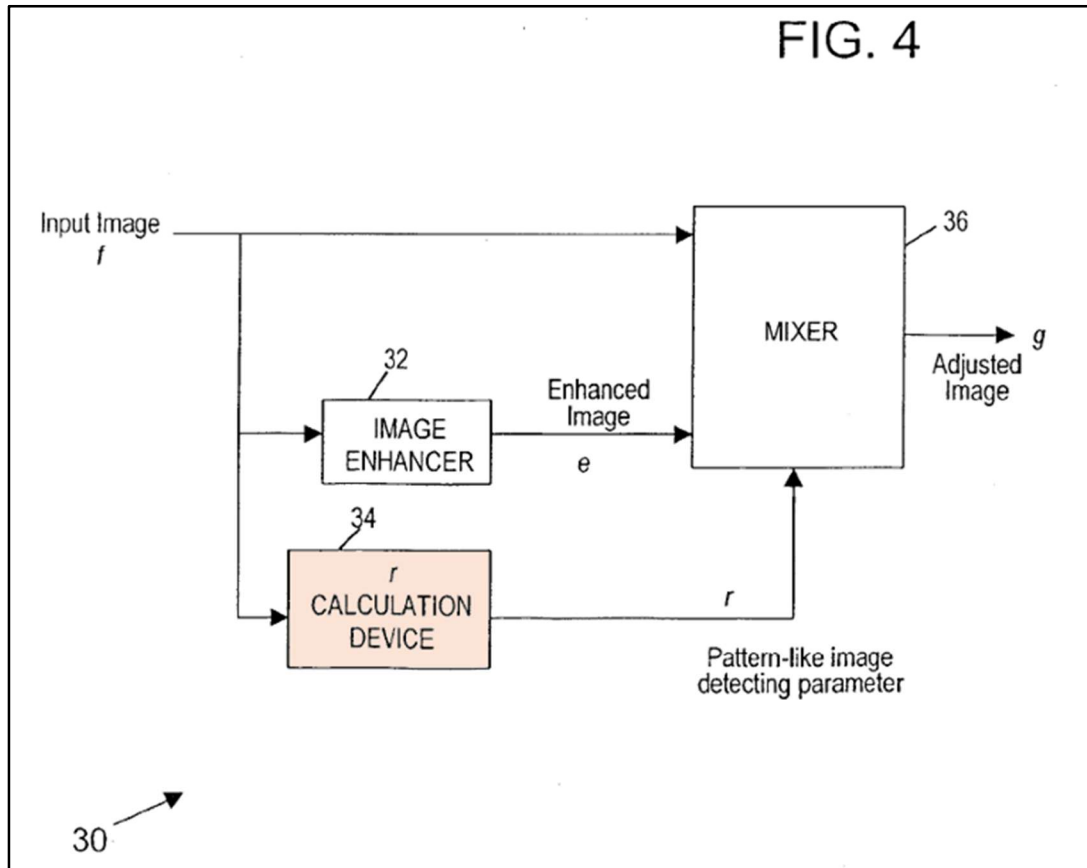
Motivation to do so arises from common sense and Fujimura, which discloses implementing any component of an image processing system in a “general-purpose processor.” *See* Ground 2, element 1.c.

5. **[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.”)**

75. Kim discloses this claim element. As described for element 1.c, Kim discloses that mixer 36 corrects image *f* from the incoming video using input *r* and according to equation 6. *Id.*, ¶42. If *r* equals 0, image *f* is “a normal input image.” *Id.*, ¶43. In that case (*when the pattern portions are not contained*), equation 6 becomes $g=e$ and mixer 36 outputs adjusted image *g* that is enhanced image *e* (*the corrector correct[s] the video signal input when the pattern portions are not contained*). *Id.*, ¶¶42-43; §§IV.C-E (constructions of this claim element). If *r* equals 1, image *f* is “a pattern-like image.” *Id.*, ¶43. In that case (*when the pattern portions are contained*), equation 6 becomes $g=f$ and mixer 36 outputs adjusted image *g* that is image *f* (*the corrector [does not] correct the video signal when the pattern portions are contained*). *See also* §§IV.D-E.

76. Kim also discloses that “*r* calculation device 34” calculates *r*, which is

input to mixer 36. EX1004, ¶43, Fig. 4 (annotated orange below). Calculation device 34 therefore is the recited *controller* that *controls* mixer 36 (at least part of *the corrector*) to correct or not correct image f from the incoming video, as described above.



This *controller* plus the portion of mixer 36 that applies equation 6 is the recited *controller* for the same reasons.

77. If Patent Owner argues that the recited *controller* must be separate from the *detector* of element 1.b, this argument is incorrect. The claim recites these elements functionally rather than structurally, and nothing in the '645 patent

or its file history prohibits them from overlapping or from one being a subpart of the other. It also would have been obvious to a POSITA to implement calculation device 34 as separate *detector* and *controller* modules, where the *detector* would calculate r and the *controller* would apply r via equation 6, as a mere design choice. Motivation to do so arises at least from a desire to compartmentalize functionality in different modules for organizational purposes.

B. Claim 2

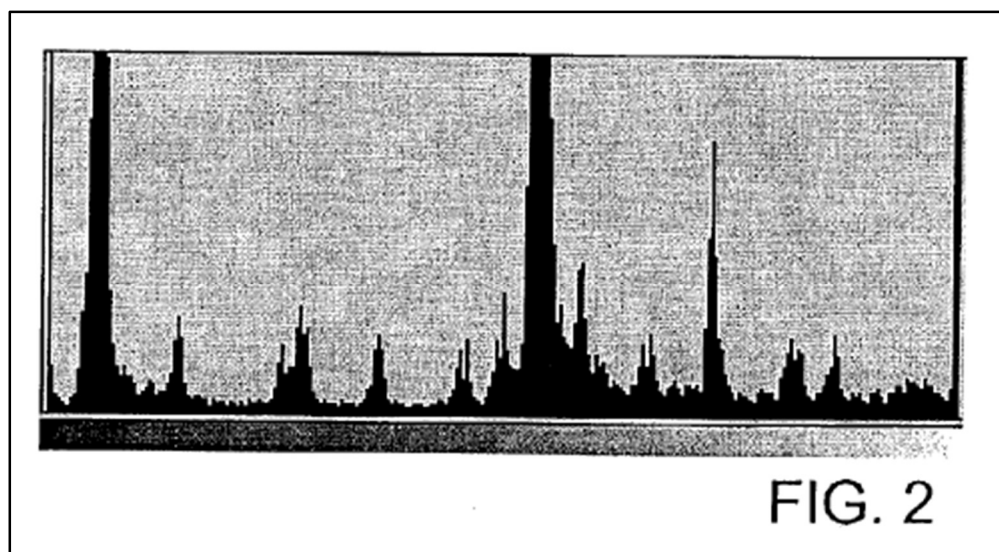
78. In my opinion, Kim discloses claim 2.

1. **[2.pre] (“The video processing apparatus according to claim 1, comprising:”).**

79. For the reasons I set forth for claim 1, Kim discloses this preamble.

2. **[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,”)**

80. Kim discloses this claim element. Kim discloses generating a histogram of the image f from the incoming video that indicates “the number of pixels [in the image] that have a specific gradation level x ... where x varies from 0 (black) to L (white),” where “ L equals 255 in a typical video system.” EX1004, ¶22. Kim’s Figure 2 shows an example of such a histogram that shows large values at certain gradation levels. *Id.*, ¶32.



In the histogram, the horizontal axis represents “gradation,” which ranges from 0 (black) to 255 (white), and the vertical axis represents the “number of pixels that have a specific gradation level x.” *Id.*, ¶22. A POSITA would have understood that this “gradation” that ranges from 0 (black) to 255 (white) is *luminance* because it represents the intensity of light for a given pixel. *Id.*, ¶22. The ’645 patent specification confirms this understanding of “luminance.” EX1001, 7:5-8 (luminance level ranges from 0 to 255), 7:52-58 (the luminance histogram shows whether an image is “simply [a] dark picture” or “a picture having a bright place such as a moon or star in a dark picture”).

81. Kim discloses that “histogram calculation device 10” determines such a histogram for each frame *f* of the incoming video, and module 10 therefore is a *characteristic point detector* that *detects a level and a distribution of luminance of the video signal*. EX1004, ¶40, Fig. 3; §IV.F (construction of “characteristic point

detector”).

82. If this claim element is construed as a means-plus-function claim element with corresponding structure of a picture quality enhancement circuit and its equivalents (EX1001, Figs. 1-2, 5:23-24), Kim discloses this structure for the reasons set forth above for element 1.c. In my opinion, a POSITA would have understood that Kim implicitly and inherently discloses that the functions of calculation device 34 are performed in a processor, circuit, or equivalent that performs picture quality enhancement, and it would have been obvious to a POSITA to implement them in such a processor, circuit, or equivalent, for the reasons set forth for element 1.c.

3. [2.b] (“wherein the corrector corrects the video signal according to the level or distribution detected by the characteristic point detector.”)

83. Kim discloses this claim element.

84. As described for element 2.a, Kim discloses a luminance histogram (a *level and distribution detected by the characteristic point detector*). As described for elements 1.c and 1.d, mixer 36 corrects image f of the incoming video based in part on parameter r. EX1004, ¶¶42-43, Fig. 4. Parameter r is calculated from the luminance histogram using equations (1) through (5). *Id.*, ¶¶22-35, ¶¶37-38, ¶40, Fig. 3. Mixer 36 (a *corrector*) therefore *corrects the video signal according to the* luminance histogram. Mixer 36 combined with image enhancer 32 (collectively,

also a *corrector*) *corrects the video signal according to the luminance histogram* for the same reasons.

C. Claim 3

85. In my opinion, Kim discloses claim 3.

2. [3.pre] (“A video processing apparatus comprising:”)

86. For the reasons I set forth for the preamble of claim 1, Kim discloses this preamble.

3. [3.a] (“an input unit to which a video signal containing contents is input;”)

87. Kim discloses this claim element. *See* element 1.a.

4. [3.b] (“a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit;”)

88. Kim discloses this claim element. *See* element 1.b.

5. [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;”)

89. Kim discloses this claim element. *See* element 2.a.

6. [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”)

90. Kim discloses this claim element. *See* element 1.c (a *corrector* that *corrects the video signal input to the input unit*). As described for claim 2, “histogram calculation device 10” (*characteristic point detector*) detects luminance

levels and distributions and outputs a luminance histogram (*detection output*), from which the system calculates parameter r (*a result of detection output*). As described for elements 1.c and 1.d, mixer 36 (at least part of the *corrector*) corrects image f according to parameter r (*changes correction characteristics according to a result of detection output*). EX1004, ¶¶42-43, Fig. 4. Specifically, the extent to which mixer 36 will apply the pixels of enhanced image e to the pixels of image f to obtain adjusted image g (*the correction characteristics*) will change proportionately with the value of r (*a result of detection output*). *Id.*, ¶42 (equation 6); *see also* §§IV.G-H (constructions of this claim element).

7. [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.”).

91. Kim discloses this claim element. As described for element 1.d, calculation device 34 is a *controller* that *controls* mixer 36 (at least part of the *corrector*) to not correct the image f when the pattern portions are contained. Specifically, when r (provided by the controller) equals 1 (*the pattern portions are contained*), the extent to which mixer 36 applies the pixels of enhanced image e to the pixels of image f to obtain adjusted image g (*the correction characteristics*) always is zero, *i.e.*, does *not change*. EX1004, ¶42 (in equation 6, “ $(1-r)$ ” becomes zero when r equals 1); §IV.I (this claim element includes such a use case); §§IV.D-E (additional constructions of this claim element).

* * *

92. If Patent Owner argues the portions of Kim cited above relate to different, incompatible embodiments (which they do not), in my opinion, it would have been obvious to a POSITA to combine such embodiments into a single system at least because such embodiments are described in the same prior art reference, are fully compatible with each other, and could be combined with minimal effort to achieve predictable results.

93. If Patent Owner argues that Kim does not disclose any element of the challenged claims, such element would have nonetheless been obvious to a POSITA in light of Kim, in my opinion. Practicing any element of the challenged claims in light of Kim would have been within the knowledge and skill of a POSITA, would have required minimal effort, would have yielded predictable results, would have been fully compatible with Kim, and would have been a mere design choice. Motivation to do so arises from at least common sense and the disclosures of Kim set forth above.

VII. GROUND 2: CLAIMS 1-4 ARE OBVIOUS IN LIGHT OF FUJIMURA

94. As set forth in detail below, in my opinion, claims 1-4 are obvious in light of Fujimura.

A. Claim 1

95. In my opinion, Fujimura discloses claim 1.

2. [1.pre] (“A video processing apparatus comprising:”)

96. Fujimura discloses this preamble. Fujimura discloses a “video contrast enhancer” (*video processing apparatus*) that “processes a video signal representing a moving picture made up of a sequence of images.” EX1005, Abstract, 2:12-13. The contrast enhancer includes a luminance contrast enhancer 2 and chrominance contrast enhancer 4, as shown in Figure 17. *Id.*, 13:34-41.

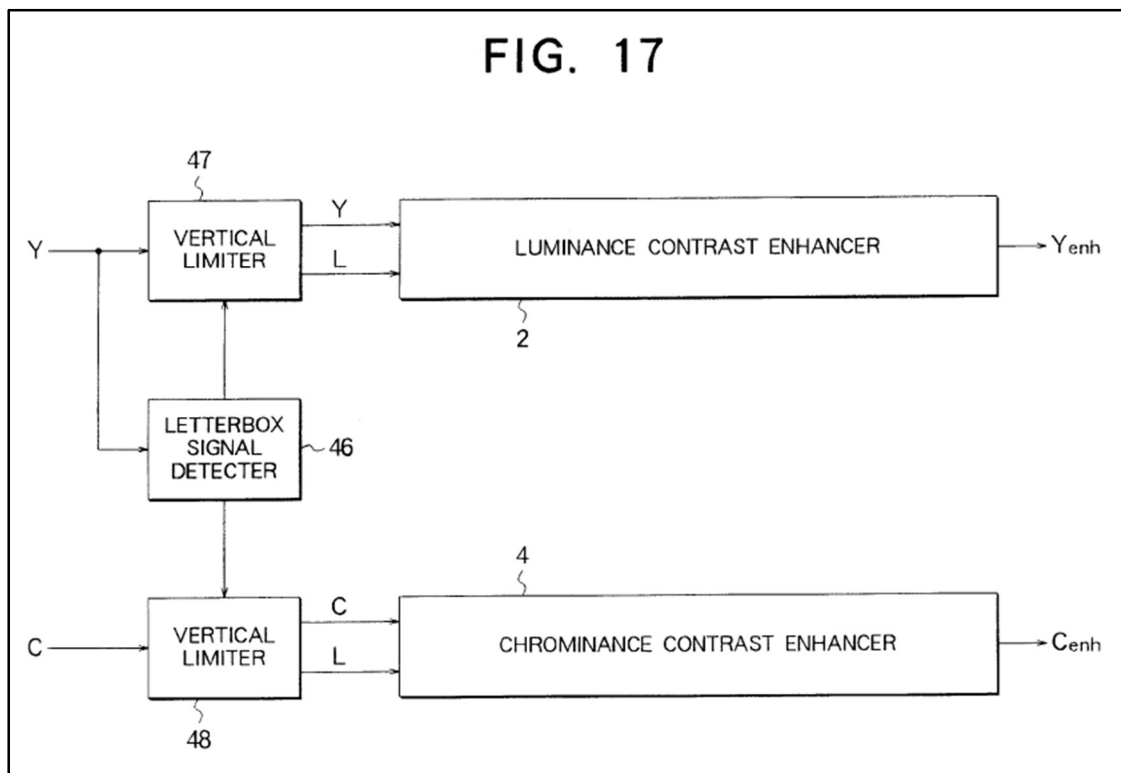


Figure 8 shows details of contrast enhancers 2 and 4 in a second embodiment. *Id.*, 13:30-41, 8:56-60, 3:63-4:5.

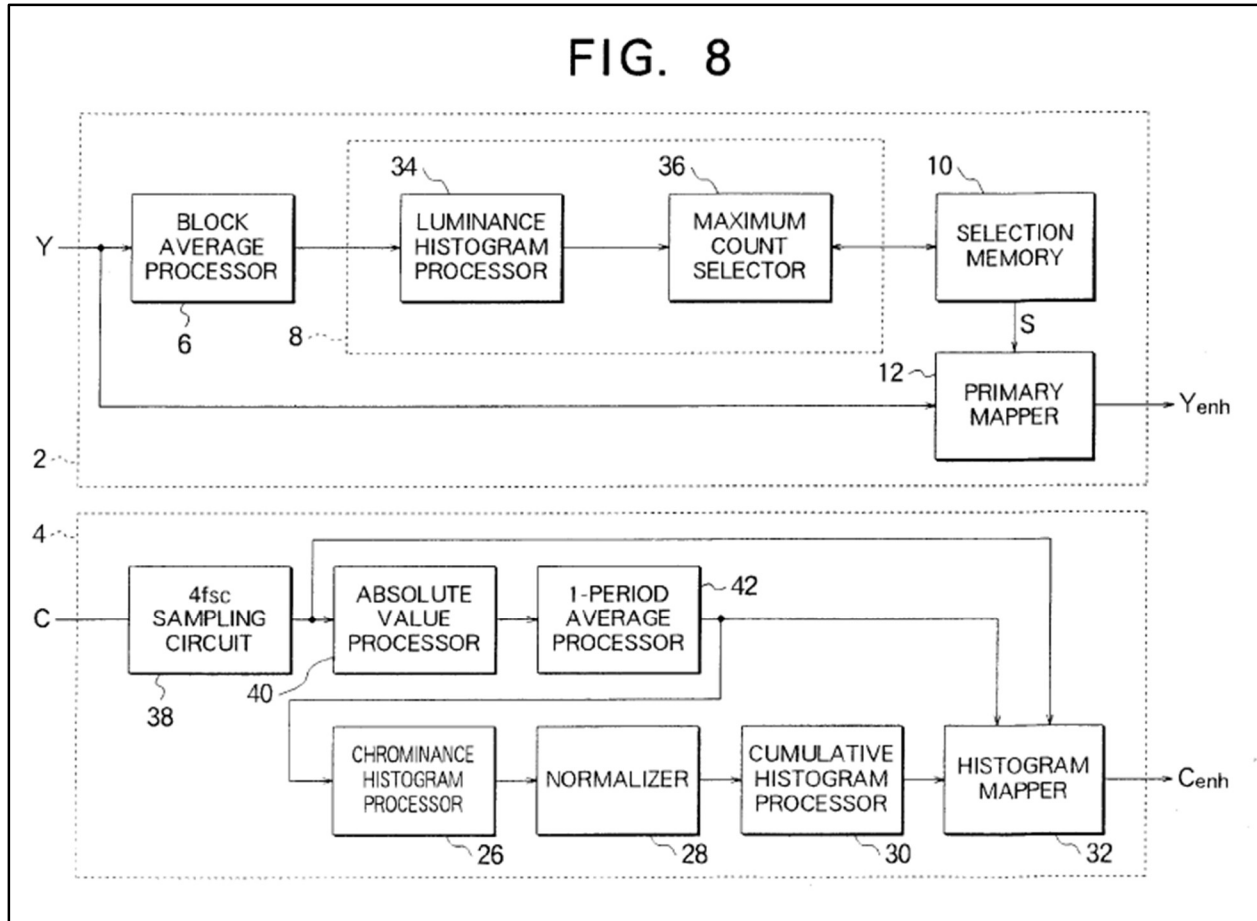
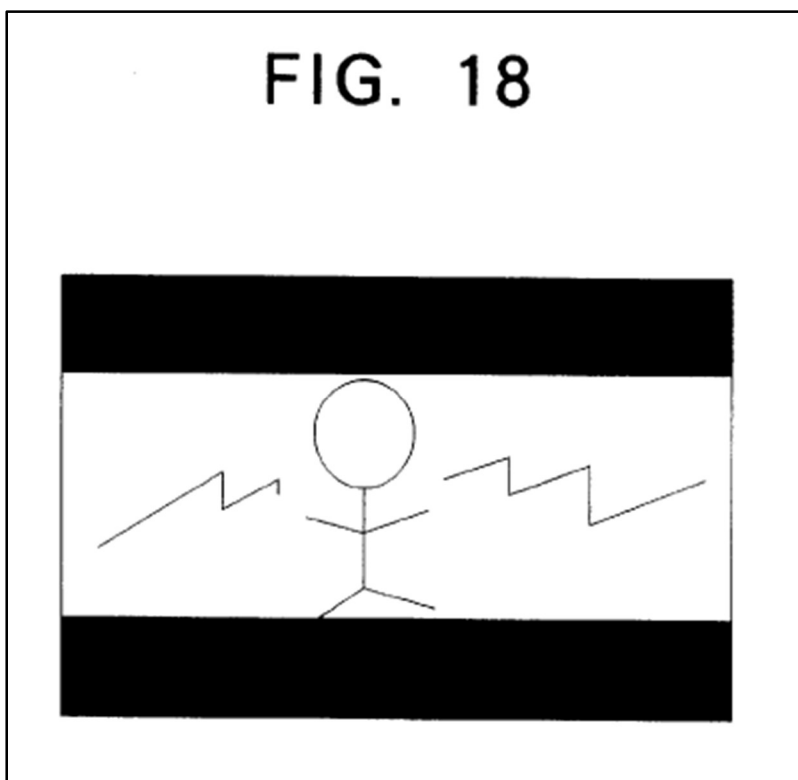


Figure 1 likewise shows details of contrast enhancers 2 and 4 in a first embodiment. *Id.*, 3:63-64. Citations to luminance enhancer 2 and its primary mapper 12 of Figure 8 apply equally to the same components of Figure 1. *Id.*, 8:56-60.

3. [1.a] (“an input unit to which a video signal containing contents is input”)

97. Fujimura discloses this claim element. Fujimura discloses video that contains a “series of frames or fields,” each of which is an “image.” EX1005, Abstract, 3:55-61. Figure 18 shows an example frame with a picture area and

black bands above and below the picture area. *Id.*, 13:42-49.



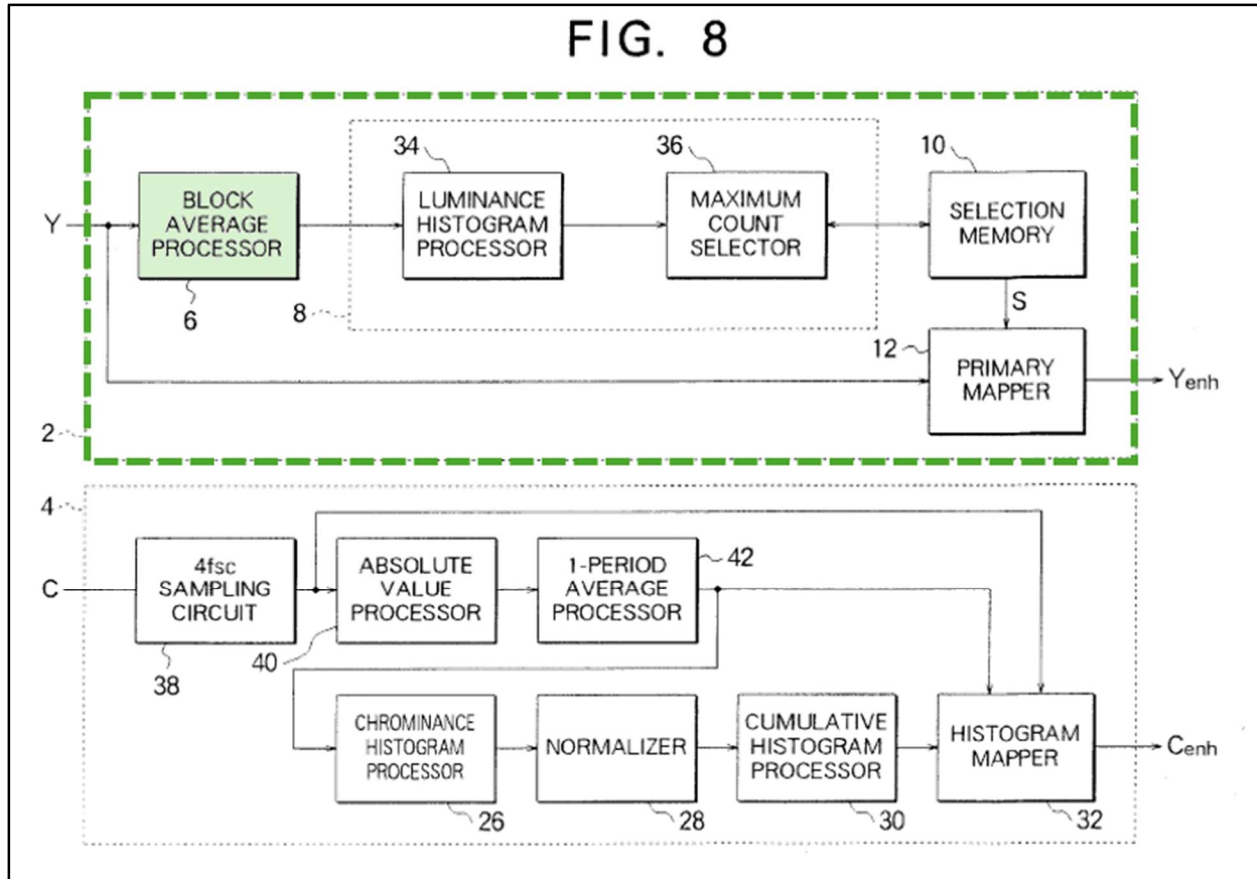
Each frame or image is made up of “horizontal scanning lines,” each of which is a row of pixels (a *video signal*). *Id.*, 13:53-58, 14:12-45 (analyzing pixels in each scanning line). A scanning line is a *video signal* because it contains video data and is part of a video input. *Id.*; §IV.A (construction of “video signal”). In addition, a scanning line in the context of Fujimura is a *video signal* because Fujimura treats a scanning line as a logical unit of video. EX1005, 13:53-58 (outputting the line numbers of the scanning lines at the top and bottom of the picture area), 14:12-17 (counting the number of bright pixels in a scanning line), 14:27-29 (counting the number of dark pixels in a scanning line). A scanning line may *contain* part of a

“picture area” (*contents*). *Id.*, Abstract, 2:49-52, 13:42-49, 14:19-22 (the “starting line of the picture area”), Fig. 18.

98. Fujimura also discloses that video data can be “separated into luminance and chrominance components,” namely, “luminance signal Y” and “chrominance signal C.” EX1005, 4:16-18, 7:38-40. Luminance and chrominance are the monochrome (black and white) and color components of an image, respectively. In particular, luminance refers to a pixel’s brightness or darkness, and chrominance refers to color saturation and hue. *Id.*, 14:8-12, 7:38-42. An image sensor in a video camera generally captures video images by representing the primary color components (red, green, and blue) of the visual scene. The primary color components can then be converted into luminance and chrominance, and integrated into a composite video signal. Such a composite video signal would be used in, for example, a “television receiver.” *Id.*, 1:3-6. The composite video signal is formed by the addition of the luminance and the modulated chrominance components into a single signal. *Id.*, Abstract, 2:43-45, 4:16-18, 7:36-40. Based on Fujimura’s disclosure that the “composite video signal” can be “separated into luminance and chrominance components,” described above, a POSITA would have understood that Fujimura must incorporate or rely on a module that separates the composite video data into its luminance and chrominance components. *Id.*, 4:16-18, 7:38-40. In other words, a POSITA would have understood that Fujimura

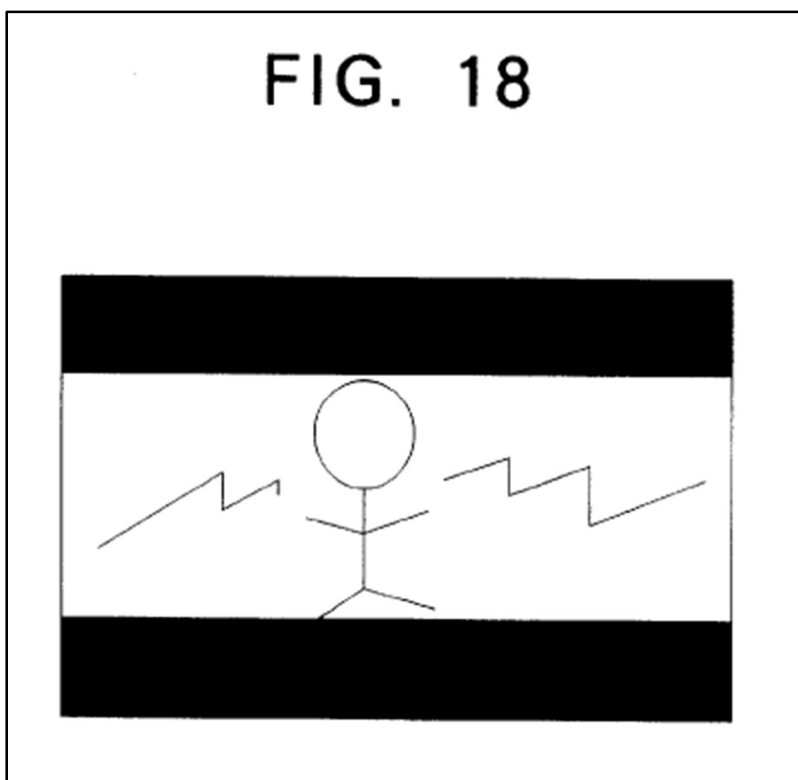
implicitly discloses such a separator module, and that such a module is necessary (inherent) to separate the composite video data into its luminance and chrominance components. This implicit separator module is an *input unit to which* a composite scanning line (*video signal*) from the video is *input*. Such a module may be part of a “digital signal processor,” which therefore also is an *input unit to which* the composite scanning line (*video signal*) is *input*. EX1005, 4:6-11.

99. Luminance signal Y indicates “the luminance levels of individual pixels in a sequence of video images constituting a moving picture.” EX1005, 4:13-16. A scanning line in luminance signal Y therefore also is a *video signal*. A scanning line in luminance signal Y also contains *contents* that are the luminance levels for the pixels in a scanning line of the “picture area” described above. *Id.* A scanning line of luminance signal Y is input into “block average processor 6” (*an input unit to which this video signal is input*), colored green below. *Id.*, 4:13-16, 8:56-65, Fig. 8. A scanning line of luminance signal Y also is input into luminance contrast enhancer 2 (also *an input unit to which this video signal is input*), outlined in green below. *Id.*, 4:11-16, 8:56-65, Fig. 8. These modules may be implemented in a “digital signal processor,” which also is *an input unit to which this video signal is input* for the same reasons. *Id.*, 4:6-11.



4. [1.b] (“a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit;”)

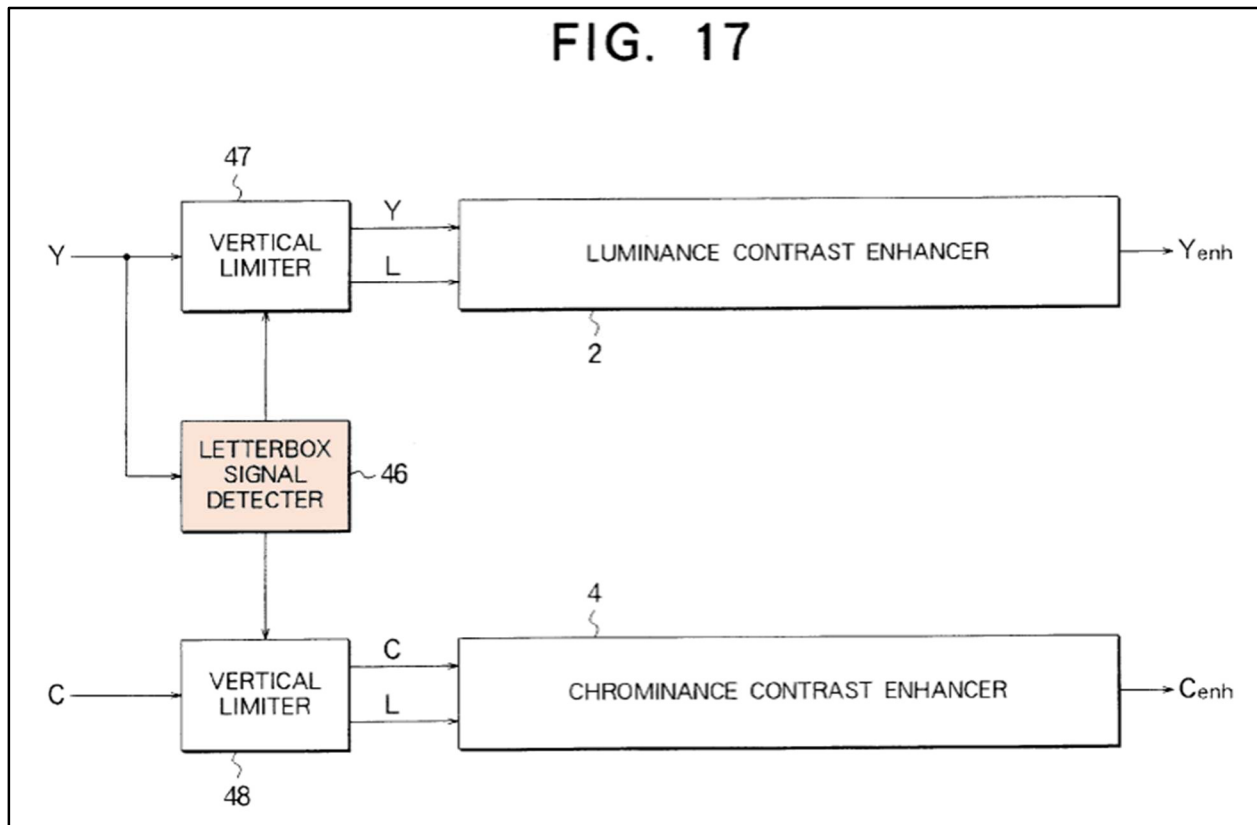
100. Fujimura discloses this claim element. As described for element 1.a, Fujimura discloses scanning lines of a composite video signal and of a luminance signal Y (each scanning line a *video signal input to an input unit*). Fujimura also discloses that a video image may contain “black non-picture bands above and below” the “picture area.” EX1005, 13:42-49, 1:51-55 (“the video signal has non-picture bands at the top and bottom”), 2:5-8 (same). Figure 18 shows an example image with such “letterbox” bands. *Id.*, 13:42-49.



In my opinion, a POSITA would have understood that because these black bands are “non-picture” bands and are “above and below” the “picture area” (*contents*) they are *pattern portions other than contents*. A scanning line (*video signal*) that includes part of such a blank band therefore *contain[s] a pattern portion other than contents*.

101. Letterbox signal detector 46 (*a detector*), annotated in orange below, “determines whether the luminance signal Y is a letterbox signal,” which a POSITA would have understood means that it determines whether the image is in letterbox format. EX1005, 13:50-58, 15:5-12, Fig. 17. If the signal is a letterbox signal, for each image, letterbox signal detector 46 “outputs a pair of line numbers specifying the starting and ending lines of the picture area in the image.” *Id.*,

14:46-50, 13:53-58, Fig. 19. Any scanning line (*video signal*) before or after the picture area contains part of the black band and therefore *contain[s] a pattern portion other than contents*. *Id.*, Fig. 18. Letterbox signal detector 46 therefore *detects whether pattern portions other than contents are contained in the video signal*.



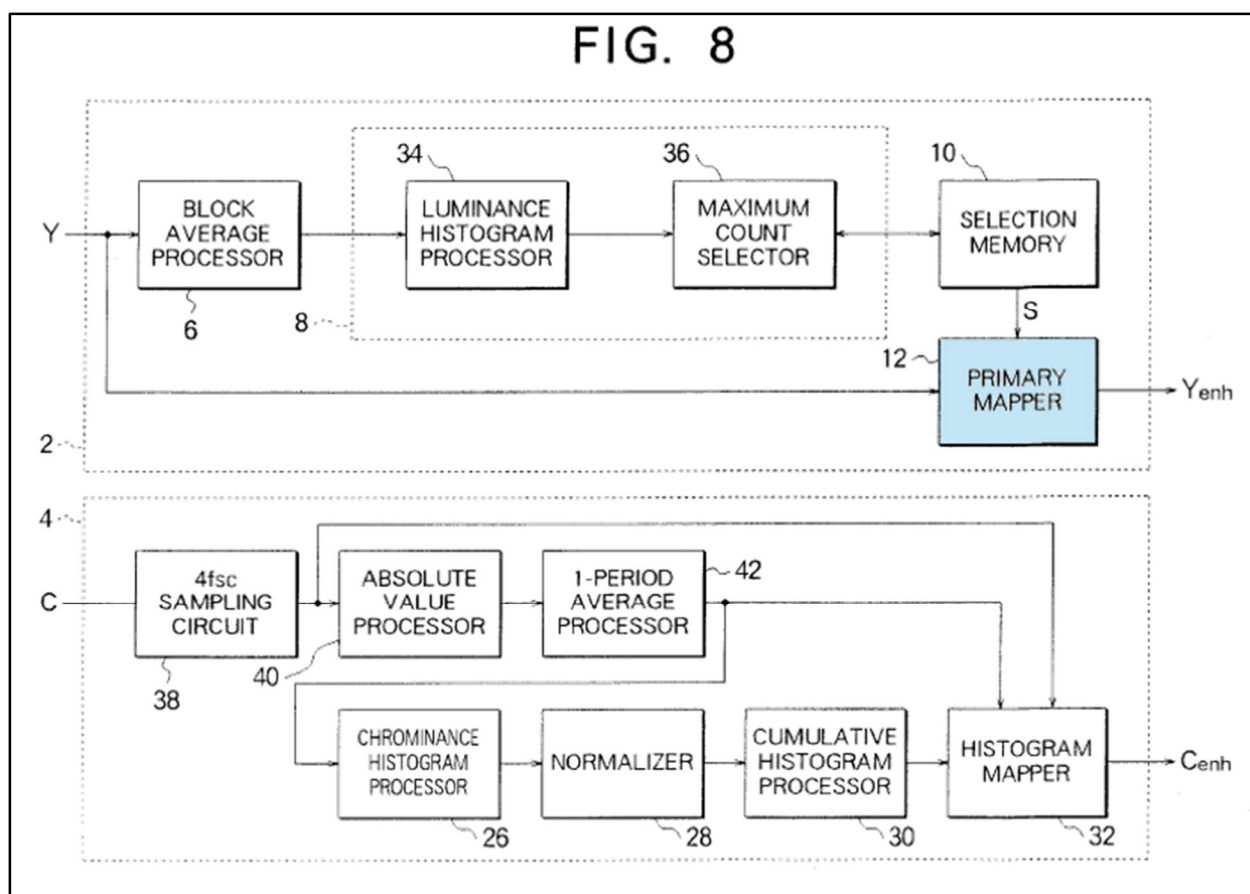
102. Fujimura also discloses this claim element in an additional way. Fujimura discloses that letterbox signal detector 46 determines whether each scanning line's number of "bright pixels" or "dark pixels" is above a certain bright-pixel threshold or dark-pixel threshold. EX1005, 14:13-36. Each pixel is classified as either bright or dark (*id.*, 14:7-12), and Fujimura determines whether

the number of dark pixels in each scanning line is beyond a threshold. Scanning lines with a sufficient number of dark pixels are classified as part of either the upper or lower non-picture black bands. *Id.*, 14:13-36. Letterbox signal detector 46 (a *detector*) therefore also determines whether a scanning line (*video signal*) includes a sufficient number of dark pixels (*a pattern portion*) rather than bright pixels (*other than content*).

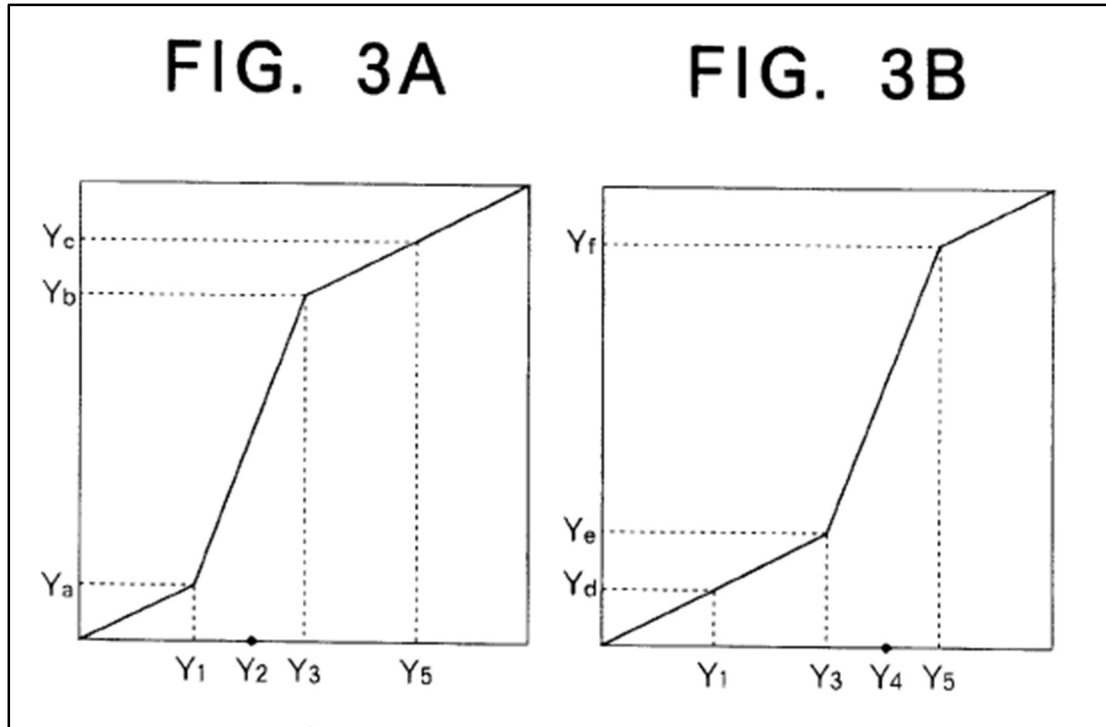
103. If this claim element is construed as a means-plus-function claim element with corresponding structure of a CPU and its equivalents, Fujimura discloses such a structure. Fujimura discloses that any circuits of luminance contrast enhancer may be implemented in “a general-purpose processor such as a digital signal processor” (a CPU or its equivalent), and it would have been obvious to a POSITA to also implement letterbox signal detector 46 in such a processor. EX1005, 3:63-4:11. Motivation to do so arises from the fact that the detector 46 would have to be implemented using at least some hardware, and from Fujimura’s disclosure above of implementing effectively any circuit of its system in a processor.

5. [1.c] (“a corrector which corrects the video signal input to the input unit; and”)

104. Fujimura discloses this claim element. Fujimura discloses that “luminance contrast enhancer 2” includes a “primary mapper 12” (*a corrector*), annotated in blue below. EX1005, 3:65-4:2, 8:56-65, Fig. 8, Fig. 1.



Primary mapper 12 uses a “mapping function” to enhance (*correct*) the luminance levels of the video pixels. *Id.*, 2:30-32 (“The primary mapper maps the luminance levels of the video signal according to the selected mapping function.”), 9:56-60 (in Figure 8, “[t]he primary mapper 12 maps all pixels according to the single mapping function”). Each mapping function “enhanc[es] contrast.” *Id.*, 6:23-28, 4:41-49 (the “mapping functions ... enhance contrast in different, but overlapping, luminance ranges”), 9:30-35 (“the mapping function ... enhances contrast in [a] luminance range”). For example, Figures 3A-B show two examples of the type of mapping functions used in mapper 12. *Id.*, 6:19-21, 6:29-32.



In each figure, “the horizontal axis represents the input luminance value, and the vertical axis represents the output value.” *Id.*, 6:21-23. Thus, primary mapper 12 *corrects the* luminance of the pixels of the scanning lines (*video signals*). See §IV.C (construction of “corrects the video signal”).

105. Luminance contrast enhancer 2 (also a *corrector*) contains primary mapper 12 and therefore *corrects the video signals* for the same reasons. EX1005, 3:65-4:2, 8:56-65, Fig. 8, Fig. 1.

106. If Patent Owner argues that the recited *corrector* must be separate from the *input unit* of element 1.a, this argument is incorrect. The claim recites these elements functionally rather than structurally, and nothing in the ’645 patent or its file history prohibits them from overlapping or from one being a subpart of

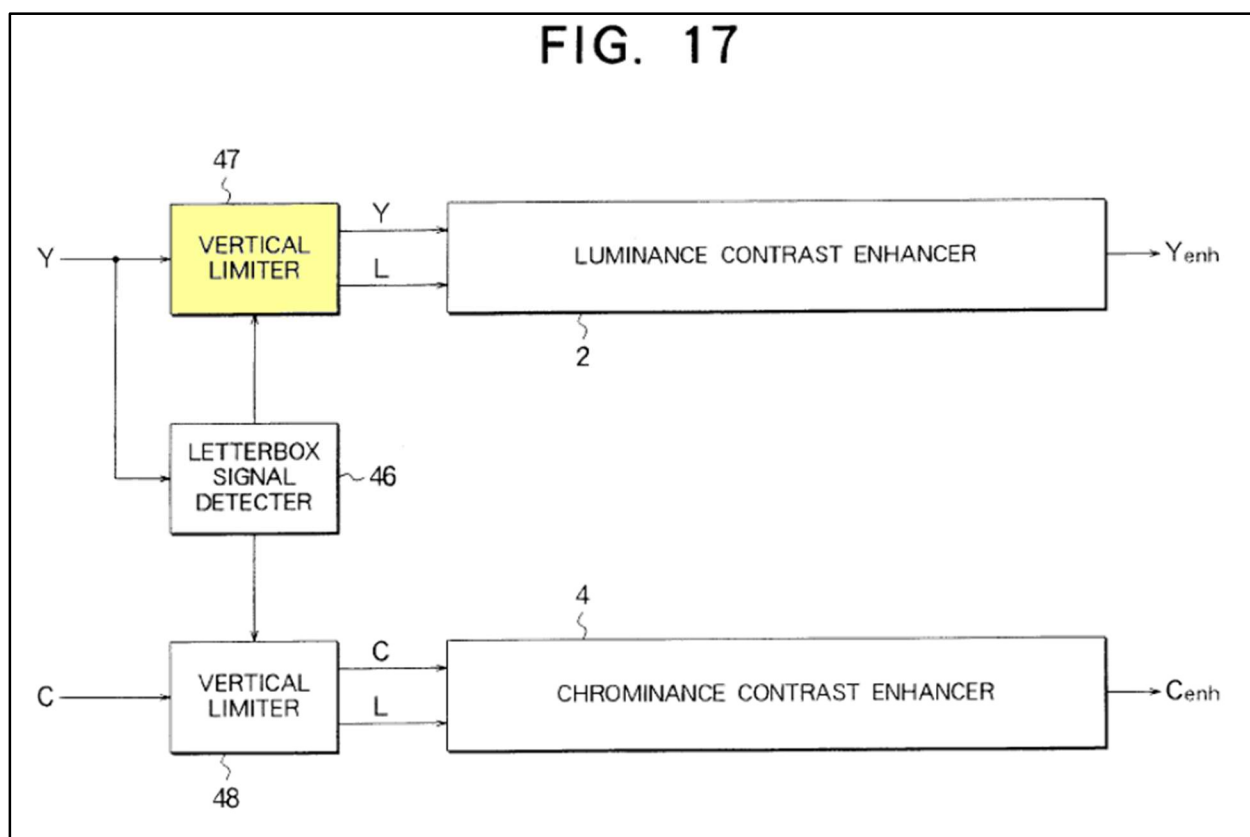
the other. Furthermore, the input to both the primary mapper 12 and luminance contrast enhancer 2 is the luminance signal Y that has been separated from the composite video signal. EX1005, Fig. 8. When considering the implicit separator module as the *input unit*, the primary mapper 12 and luminance contrast enhancer 2 (each a *corrector*) are separate from the *input unit*.

107. If Patent Owner argues that this claim element is a means-plus-function claim element, Fujimura discloses Patent Owner's proposed corresponding structure from litigation ("CPU 7 or equivalents thereof"). See §IV.B. Fujimura discloses that primary mapper 12 and luminance contrast enhancer 2 (each a *corrector*) may be implemented in "a general-purpose processor such as a digital signal processor" (a CPU or its equivalent). EX1005, 3:63-4:11.

6. **[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.")**

108. Fujimura discloses this claim element. As described for element 1.b, letterbox signal detector 46 determines whether a scanning line (*video signal*) contains part of black non-picture bands (*pattern portions*) by determining the starting and ending line of the picture area. EX1005, 13:50-58. Letterbox signal detector 46 provides the result of this determination to vertical limiter 47. *Id.*, 13:52-60, Fig. 17.

109. Vertical limiter 47, annotated in yellow below, converts this information to “letter box control signal L,” which it provides to luminance contrast enhancer 2. EX1005, 13:60-63, 14:46-56, Fig. 17. When the image includes black non-picture bands, letterbox control signal L “restrict[s] the luminance and chrominance contrast enhancement processing described in the first three embodiments to the picture area between the non-picture bands.” *Id.*, 13:64-14:1, Abstract (“[f]or video signals with non-picture bands, these enhancements are preferably restricted to the picture area”), 2:49-52 (“contrast enhancement processing can be limited to the picture area”).



110. Specifically, the “contrast enhancement operations described in the

first three embodiments are restricted to the area between the starting and ending lines of the picture area, including the starting line but not the ending line.”

EX1005, 14:50-59. The “starting line” of this passage is the line “where the picture area starts.” *Id.*, 14:12-24. The “ending line” of this passage is the first line of the bottom black band. *Id.*, 14:25-36 (“The first line in which the dark-pixel count exceeds the third threshold is regarded as the end of the picture area, i.e. the first line of the lower non-picture band.”). The luminance contrast enhancer therefore enhances each scanning line of the picture area, but not the scanning lines of the black non-picture bands.

111. Thus, vertical limiter 47 is a *controller* that *controls* luminance contrast enhancer 2 (a *corrector* of element 1.c) and its primary mapper 12 (an additional *corrector* of element 1.c) by limiting their luminance contrast enhancement to the scanning lines of the picture area. Specifically, vertical limiter 47 causes the *correctors* to enhance (*correct*) the luminance of the pixels of a scanning line (*video signal*) *when* the scanning line does not contain *pattern portions* (*i.e.*, the scanning line is part of the picture area) and *not to* enhance (*correct*) the luminance of the pixels of a scanning line (*video signal*) *when* the scanning line contains *pattern portions* (*i.e.*, the scanning line is part of the black non-picture bands). *See* §§IV.C-E (constructions of this claim element).

B. Claim 2

112. In my opinion, Fujimura discloses claim 2.

- 2. [2.pre] (“The video processing apparatus according to claim 1, comprising:”).**

113. Fujimura discloses this preamble. *See* claim 1.

- 3. [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,”)**

114. Fujimura discloses this claim element. As described for element 1.b, Fujimura discloses “letterbox signal detector 46.” EX1005, 13:50-58, Fig. 17. Letterbox signal detector 46 “determines whether the luminance signal Y is a letterbox signal.” *Id.*, 13:50-58, Fig. 18 (letterbox format). To do so, its comparator 50 classifies each pixel in a scanning line (*video signal*) as “bright” or “dark” depending on the pixel’s “luminance level.” *Id.*, 14:7-12, Fig. 19 (example internal structure of the letterbox signal detector). Doing so *detects a level of luminance* for each pixel in a scanning line (*video signal*) and therefore *detects a level of luminance* of the scanning line (*video signal*). Detector 46 also includes “bright-pixel counter 52,” which “counts the number of bright pixels in each horizontal scanning line.” *Id.*, 14:13-17. Counting the number of bright pixels in a scanning line (*video signal*) also *detects a level of luminance* of the scanning line (*video signal*) because a greater count indicates a scanning line with higher level of luminance. Detector 46 also includes “dark-pixel counter 56,” which, upon

activation, “count[s] the number of dark pixels in each horizontal scanning line” (*video signal*). *Id.*, 14:25-29. Counting the number of dark pixels in a scanning line (*video signal*) also *detects a level of luminance* of the scanning line (*video signal*) because a greater count indicates a scanning line with a lower level of luminance. Counting the number of bright pixels or dark pixels in a scanning line (*video signal*) also *detects a distribution of luminance* in the scanning line (*video signal*) because it determines how many bright or dark pixels are distributed in the scanning line. Thus, letterbox signal detector 46 is a *characteristic point detector* that *detects a level and distribution of luminance of the video signal*. See also §IV.F (construction of “characteristic point detector”).

115. If Patent Owner argues that the recited *characteristic point detector* must be separate from the recited *detector*, it is incorrect. The claim recites these elements functionally rather than structurally, and nothing in the ’645 patent or its file history prohibits them from overlapping, being nested, or being the same.

116. If this claim element is construed as a means-plus-function claim element with corresponding structure of a picture quality enhancement circuit and its equivalents (EX1001, Figs. 1-2, 5:23-24), Fujimura discloses and renders obvious such a structure. Fujimura discloses that the circuits of its luminance contrast enhancer 2 may be implemented in “a general-purpose processor such as a digital signal processor,” which would be a picture quality enhancement circuit

because it would enhance luminance contrast. EX1005, 3:63-4:11. It would have been obvious to a POSITA to also implement letterbox signal detector 46 in such a processor, circuit, or equivalent. Motivation to do so arises from the fact that the detector 46 would have to be implemented using at least some hardware, and from Fujimura's disclosure above of implementing effectively any circuit of its system in a processor.

4. [2.b] (“wherein the corrector corrects the video signal according to the level or distribution detected by the characteristic point detector.”)

117. Fujimura discloses this claim element. As described for element 2.a, Fujimura discloses that letterbox signal detector 46 (a *characteristic point detector*) detects bright pixels and dark pixels, and detects the number of bright or dark pixels in each scanning line (*detects a level and distribution*). Letterbox signal detector 46 uses this information to detect the starting line of the picture area and the first line of the lower non-picture black band. EX1005, 14:7-50, Fig. 19; *see also* elements 1.b and 1.d. In turn, and as described for element 1.d, primary mapper 12 (a *corrector*) uses this information to restrict luminance contrast enhancement “to the picture area between the non-picture bands.” *Id.*, 13:60-14:1, 14:46-56, Fig. 17. Thus, primary mapper 12 *corrects the video signal according to the level and distribution detected by the characteristic point detector*.

118. Luminance contrast enhancer 2 (also a *corrector*) contains primary

mapper 12 and therefore *corrects the video signal according to the level and distribution detected by the characteristic point detector* described above for the same reason that primary mapper 12 does. If Patent Owner argues that the recited *characteristic point detector* must be separate from the recited *corrector*, it is incorrect. The claim recites these elements functionally rather than structurally, and nothing in the '645 patent or its file history prohibits them from overlapping or from one being a subpart of the other.

C. Claim 3

119. In my opinion, Fujimura discloses and renders obvious claim 3.

2. [3.pre] (“A video processing apparatus comprising:”)

120. Fujimura discloses this preamble. *See* claim 1, preamble.

3. [3.a] (“an input unit to which a video signal containing contents is input;”)

121. Fujimura discloses this claim element. *See* element 1.a.

4. [3.b] (“a detector which detects whether pattern portions other than contents are contained in the video signal input to the input unit;”)

122. Fujimura discloses this claim element. *See* element 1.b.

5. [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;”)

123. Fujimura discloses this claim element. *See* element 2.a (letterbox signal detector 46 is a *characteristic point detector*).

124. In addition, letterbox signal detector 46 combined with luminance histogram processor 34 also is a *characteristic point detector* for the same reasons that letterbox signal detector 46 alone is a *characteristic point detector*. EX1005, 8:56-67, Fig. 8.

6. **[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”)**

125. Fujimura discloses this claim element. As described for element 1.c, Fujimura discloses luminance contrast enhancer 2 and its primary mapper 12 (each a *corrector*) that *corrects the scanning line (video signal input to the input unit)*.

126. As described for claim 2, letterbox signal detector 46 is a *characteristic point detector*. It outputs “a pair of line numbers specifying the starting and ending lines of the picture area” (*detection output*). EX1005, 14:46-50, 13:53-58, Fig. 19; *see also* elements 1.b and 1.d. Vertical limiter 47 “convert[s] this information to the necessary letterbox control signal[] L” (*a result of detection output*). *Id.*, 14:50-56, 13:59-60, Fig. 17. As described for element 1.d, vertical limiter 47 provides letterbox control signal L to luminance contrast enhancer 2 (*a corrector*) and its primary mapper 12 (also a *corrector*) so that luminance contrast enhancement is restricted “to the picture area between the non-picture bands.” *Id.*, 13:60-14:1, 14:46-56, Fig. 17. In other words, no luminance contrast enhancement is performed on scanning lines of the black non-picture

bands. *See* element 1.d. And, as described for element 1.c, primary mapper 12 (and luminance contrast enhancer 2) enhances a scanning line's luminance using a particular "mapping function." Each mapping function defines a mapping of each input luminance value to an output luminance value (*correction characteristics*), as described for element 1.c. *Id.*, 6:19-28, Figs. 3A-B. In the embodiment of Figure 8, "[o]ne mapping function is selected for each image," and the mapping function therefore would change between scanning lines of different images. *Id.*, 9:38-39. In the embodiment of Figure 1, the applicable mapping functions likewise change from image to image and from block to block within an image. *Id.*, 6:16-18, 4:40-43 (a mapping function for each block), 6:11-16 (the selection signal changes "for a particular block").

127. Thus, each *corrector* applies different (*changes*) mapping functions (that include *correction characteristics*) to scanning lines within the picture area based in part on (*according to*) letterbox control signal L (*a result of detection output from the characteristic point detector*) indicating that the scanning line is within the picture area and therefore should undergo luminance contrast enhancement. *See* §§IV.C, G-H (constructions of this claim element).

128. Moreover, primary mapper 12 combined with "maximum count selector 36" is a *corrector* for the same reason that primary mapper 12 is a *corrector*, and also because maximum count selector 36 generates a mapping

function number corresponding to the mapping function to use for luminance contrast enhancement. EX1005, 9:25-35. This *corrector* (primary mapper 12 combined with maximum count selector 36) also *changes* the mapping functions (that include *correction characteristics*) by generating the mapping function number of the applicable mapping function.

* * *

129. In addition, as described for element 3.c, letterbox signal detector 46 combined with luminance histogram processor 34 also is a *characteristic point detector*. Luminance histogram processor 34 receives from “block average processor 6” the “mean luminance level of all the pixels” in the image. EX1005, 9:10-13, 4:13-39, Fig. 2. It uses this data to “construct[] a histogram of the mean [luminance] values” (*detection output*) for each image. *Id.*, 9:10-13, Fig. 9 (example histogram). It then passes the histogram to “maximum count selector 36,” which analyzes the histogram to identify a “mapping-function number” (*a result of detection output*) for the image. *Id.*, 9:25-30, Fig. 8. The mapping-function number is used to apply the appropriate mapping function (that includes *correction characteristics*) for luminance contrast enhancement. *Id.*, 9:30-35. Thus, each *corrector* described above applies different (*changes*) mapping functions (that include *correction characteristics*) based in part on (*according to*) the mapping-function number (*a result of detection output from the characteristic*

point detector). See §§IV.C, G-H (constructions of this claim element). Fujimura therefore discloses this claim element in this additional way.

* * *

130. If Patent Owner argues that this claim element is a means-plus-function claim element, Fujimura discloses Patent Owner's proposed corresponding structure from litigation ("CPU 7 or equivalents thereof"). See §IV.B. Fujimura discloses that primary mapper 12 and luminance contrast enhancer 2 (each a *corrector*) may be implemented in "a general-purpose processor such as a digital signal processor." EX1005, 3:63-4:11. Maximum count selector 36 also may be implemented in such a processor because it is part of mapping function selector 8 and luminance contrast enhancer 2, each which may be implemented in such a processor. *Id.*, Fig. 8, 8:56-67, 3:63-4:11, Fig. 1.

1. **[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.").**

131. Fujimura discloses this claim element. As described for element 1.d, Fujimura discloses vertical limiter 47 (*a controller*) that provides letterbox control signal L to luminance contrast enhancer 2 (*a corrector*) and its primary mapper 12 (also *a corrector*) so that luminance contrast enhancement is restricted "to the picture area between the non-picture bands." EX1005, 13:60-14:1, 14:46-56, Fig. 17. In other words, no luminance contrast enhancement is performed on scanning

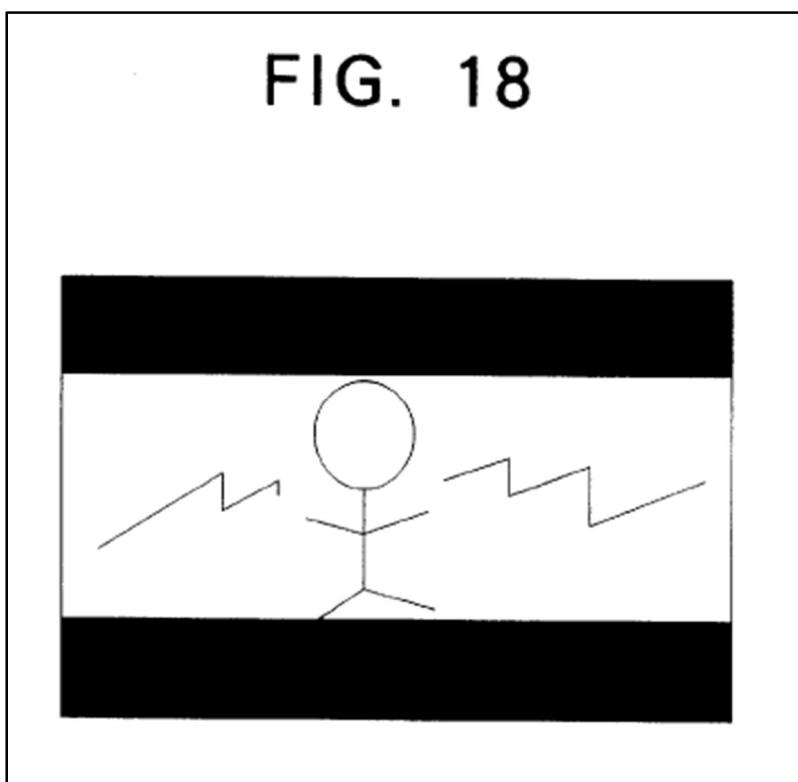
lines that contain part of a black non-picture band (*when the pattern portions are contained* in the scanning line). See element 1.d; §§IV.D-E (constructions of this claim element). In that case, no mapping function (that includes *correction characteristics*) is selected or applied because no luminance contrast enhancement is performed. Luminance contrast enhancer 2 instead would apply no function to the scanning line or apply an “identity function, which leaves the luminance ... unchanged,” and which Fujimura distinguishes from a mapping function. EX1005, 14:1-6. Thus, each *corrector* does not select or apply, and therefore does *not change*, a mapping function (that includes *correction characteristics*) *when* the scanning line contains part of a black non-picture band (a *pattern portion* is *contained*). And such behavior is *control[ed]* by letterbox control signal L from vertical limiter 47 (*a controller*), as described above.

132. In addition, in the case where the *corrector* applies the “identity function” to “leave[] the luminance ... unchanged,” the *corrector* also does *not change* the *correction characteristics* because it applies a function that is constant (does not change) every time *the pattern portions are contained*. See §IV.I (this claim element includes such a use case). Fujimura therefore discloses this element in this additional way. Also, it would have been obvious to a POSITA to apply the disclosed identity function to leave the luminance unchanged. Motivation to do so arises from Fujimura’s disclosure that the identity function can be used for that

purpose.

- D. Claim 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.”)**

133. Fujimura discloses this claim element. As described for element 1.b, Fujimura discloses that an image in each of the *video signals* of element 1.a may contain *pattern portions* that are “black non-picture bands above and below” the “picture area.” EX1005, 13:42-49, Fig. 18, 1:51-55, 2:5-8. Figure 18 shows an example image with such “letterbox” bands. *Id.*, 13:42-49.



Such bands *hav[e] a single color* because they are black. *Id.* Such bands also are *added* to account for different aspect ratios between the screen and the original

image. *Id.*, 13:44-49. The bands also are *above and below the* “picture area” (*contents*), as described above. *See also* element 1.a (the picture area *contents*). The bands are “non-picture bands” (*no-picture areas*). EX1005, Abstract, 1:51-55, 2:5-8, 13:53-58, 13:64-14:1, 14:56-59, Fig. 18. The bands also are *wallpaper areas* because they are rectangular patterns that are a result of the screen having a different aspect ratio than the image. *Id.*, 13:44-49; EX1001, 1:41-50 (“wallpaper” portions are added to account for differing aspect ratios), 1:51-54 (they may be “black no-picture areas”). The black bands also [*are*] *displayed*, as shown in Figure 18.

* * *

134. If Patent Owner argues the portions of Fujimura cited above relate to different, incompatible embodiments (which they do not), it would have been obvious to a POSITA to combine such embodiments into a single system at least because such embodiments are described in the same prior art reference, are fully compatible with each other, and could be combined with minimal effort to achieve predictable results.

135. If Patent Owner argues that Fujimura does not disclose any element of the challenged claims, such element would have nonetheless been obvious to a POSITA in light of Fujimura. Practicing any element of the challenged claims in light of Fujimura would have been within the knowledge and skill of a POSITA,

would have required minimal effort, would have yielded predictable results, would have been fully compatible with Fujimura, and would have been a mere design choice. Motivation to do so arises from at least common sense and the disclosures of Fujimura set forth above.

VIII. GROUND 3: CLAIMS 5-8 ARE OBVIOUS IN LIGHT OF FUJIMURA AND KIM

136. As set forth in greater detail below, in my opinion, claims 5-8 are obvious in light of Fujimura and Kim.

A. Claim 5

In my opinion, Fujimura combined with Kim discloses claim 5.

1. [5.pre] (“A video processing apparatus comprising:”)

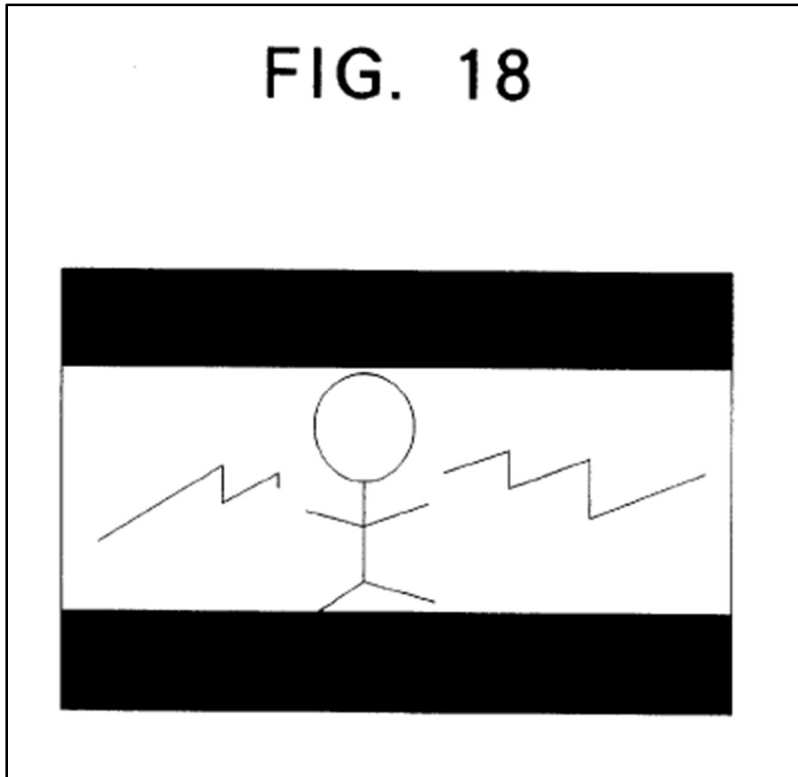
137. Fujimura discloses this preamble. *See* Ground 2, claim 1, preamble.

2. [5.a] (“an input unit to which a video signal containing contents is input;”)

138. Fujimura discloses this claim element. As described for element 1.a in Ground 2, Fujimura discloses video that contains a “series of frames or fields,” each of which is an “image.” EX1005, Abstract, 3:55-61. Each such frame or image is a *video signal* because it contains video data and is part of a video input.

Id., Fig. 18, 13:42-49; §IV.A (construction of “video signal”).¹ It also makes sense for an image in Fujimura to be a *video signal* because Fujimura treats an image as a logical unit of video. EX1005, 9:13 (one histogram is constructed per image), 9:38-39 (one mapping function can be selected per image), 13:12-15 (same), 14:46-50 (letterbox signal detector operates on “each image”), Fig. 18. Each image may *contain* a “picture area” (*contents*). Abstract, 2:49-52, 13:42-49, 14:12-34. Figure 18 shows an example frame with a picture area and black bands above and below the picture area. *Id.*, 13:42-49.

¹ I understand from counsel that mapping “video signal” to different video signals in Fujimura for different claims is proper as long as the language of the claims and the disclosure of Fujimura support those mappings, which they do.



139. As described for element 1.a in Ground 2, the module that separates each composite image (*video signal*) into its component “luminance signal Y” and “chrominance signal C” is an *input unit* to which the composite image (*video signal*) is *input*. An image of luminance signal Y is input into “block average processor 6” (also an *input unit* to which this *video signal* is *input*). See element 1.a in Ground 2. An image of luminance signal Y also is input into luminance contrast enhancer 2, which also is an *input unit* to which this *video signal* is *input*. These modules may be implemented in a “digital signal processor,” which also is an *input unit* to which this *video signal* is *input* for the same reasons. *Id.*

3. [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;”)

140. Fujimura discloses this claim element. *See* Ground 2, element 1.a (a *video signal input to an input unit*). As described for element 1.b in Ground 2, letterbox signal detector 46 is a *pattern portion detector* because it detects the *pattern portions* described for element 1.b in Ground 2 (black non-picture bands above and below the picture area). Such pattern portions may be contained in each image (*the video signal*). EX1005, 13:42-49, 1:51-55, Fig. 18.

141. If this claim element is construed as a means-plus-function claim element with corresponding structure of a CPU and its equivalents, Fujimura discloses such a structure for the reasons set forth for element 1.b in Ground 2.

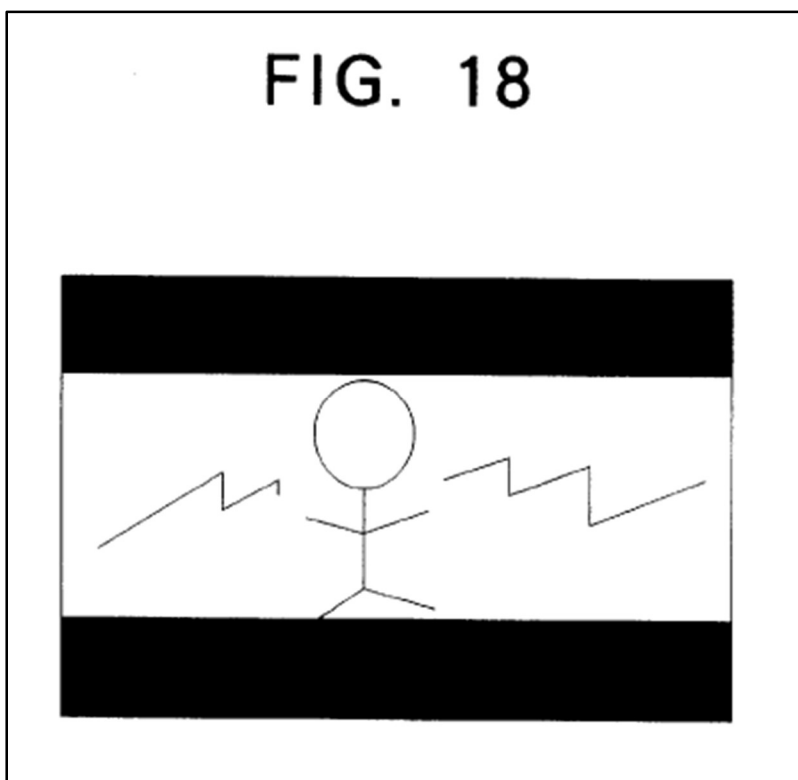
4. [5.c] (“a no-picture area detector which detects whether the pattern portions are no-picture areas having a single color;”)

142. Fujimura discloses this claim element. *See* Ground 2, element 1.b.

143. As described for element 1.b in Ground 2, Fujimura discloses that each image (each composite image and each image in the luminance signal Y) may be a “letterbox signal.” EX1005, 13:44-49 (luminance signal Y may be a letterbox signal), 2:49-52 (video signal that is a letter-box signal), Fig. 18 (image in letterbox format). A POSITA also would have understood that if an image of luminance signal Y has letterbox format (*i.e.*, has non-picture black bands on the

top and bottom of the image), then the corresponding composite image from which an image of luminance signal Y is separated also has a letterbox format. *Id.*, 4:16-18. Otherwise (if the composite image were not a letter-box signal), the image of luminance signal Y would not be a letterbox signal because luminance signal Y indicates each pixel's brightness or darkness. *Id.*, 14:8-12, 7:38-42.

144. “Letterbox signals are produced for the purpose of reproducing a picture having one aspect ratio on a screen having a different aspect ratio, as when an extended-definition television (EDTV) signal having a 16:9 aspect ratio is to be reproduced on a screen having a 4:3 aspect ratio.” EX1005, 13:44-49. Figure 18 shows an example of such letterbox bands, which is consistent with how a POSITA would have understood letterbox signal or letterbox format—one that includes non-picture black bands on the top and bottom of the image. *Id.*, 13:42-49, 1:51-55, 2:5-8.



The “black non-picture bands above and below” the “picture area” are *pattern portions* that are *no-picture areas having a single color* (black). *Id.*, 13:42-49; *see also* claim 4 (*no-picture areas having a single color*).²

145. Fujimura discloses that “the letterbox signal detector 46 determines whether the luminance signal Y is a letterbox signal.” EX1005, 13:52-53. Thus, letterbox signal detector 46 detects whether the video signals include letterbox bands (*pattern portions* that are *no-picture areas having a single color*) and is a

² Although Fujimura discloses that the bottom black band may include captions, in the disclosed case where it does not, it is a single color (black). EX1005, 13:53-58, 14:1-6, Fig. 18.

no-picture area detector.

146. Specifically, Fujimura discloses that letterbox signal detector 46 can identify a letterbox signal by, for example, “decod[ing] the ID code” of the video signal to determine that it is of type “type-II extended definition television (EDTV-II).” *Id.*, 15:5-12. Detector 46 can then “set the starting and ending lines [of the picture area] as specified in the standards for the identified signal type.” The EDTV-II type video signal included letterbox bands. *See* EX1006, 3 (EDTV-II included a “mandatory” “[l]etterbox” format”).

147. If Patent Owner argues that the recited *no-picture area detector* must be separate from the *pattern portion detector* of element 5.b, it is incorrect. The claim recites these elements functionally rather than structurally, and nothing in the ’645 patent or its file history prohibits them from overlapping or from one being a subpart of the other.

5. [5.d] (“a corrector which corrects the video signal input to the input unit; and”)

148. Fujimura discloses this claim element. As described for element 1.c in Ground 2, luminance contrast enhancer 2 (a *corrector*) and its primary mapper 12 (a *corrector*) enhance (*correct*) the luminance of pixels of a scanning line. Because each image (*video signal input to the input unit*) is a series of scanning lines, as described for element 1.a in Ground 2, they also do so for an image (*video signal*). EX1005, 13:53-58, 14:12-45; *see also id.*, 9:38-39 (mapping function for

an image), 6:11-18 (mapping functions for blocks in an image); §IV.C

(construction of “corrects the video signal”).

6. [5.e.i] (“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,”)

149. Fujimura discloses this claim element. As described for element 5.d, luminance contrast enhancer 2 (a *corrector*) and its primary mapper 12 (a *corrector*) enhance (*correct*) the luminance of an image (*video signal input to the input unit*).

150. As described for element 1.d in Ground 2, vertical limiter 47 is a *controller which controls each corrector by providing letterbox control signal L to cause each corrector to correct scanning lines when the scanning line does not contain the pattern portions (i.e., when the scanning line contains part of a picture area)*. Because each image (*video signal input to the input unit*) is a series of scanning lines, as described for element 1.a in Ground 2, the *controller* also does so for an image (*video signal*). In other words, when an image (*video signal*) does not contain the black non-picture bands or other pattern portion (*when the pattern portions are not contained*), and is purely a picture area, luminance contrast enhancer 2 (a *corrector*) and its primary mapper 12 (also a *corrector*) enhance (*correct*) the luminance of pixels of the image (*video signal*). See element 1.c in Ground 2 (each *corrector* corrects luminance contrast), element 1.d in Ground 2

(each *corrector* does so for picture areas); EX1005, 2:30-32, 9:56-60 (in Figure 8, the primary mapper 12 applies a mapping function to all pixels); *see also* §§IV.D-E (constructions of this claim element).

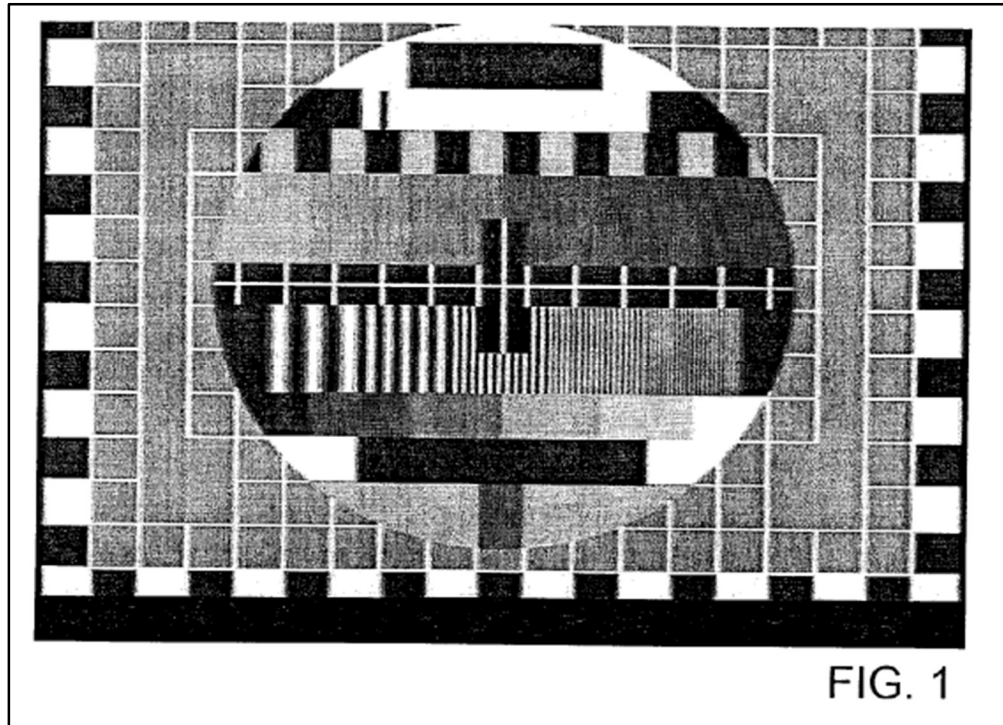
151. Next, as described for element 5.c, an image (*video signal*) may contain “non-picture bands above and below” the “picture area” of a single color (black) (*the pattern portions are the no-picture areas*). EX1005, 13:42-49. In that case (*when the pattern portions are the no-picture areas*), each *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*). As described for element 1.d in Ground 2, such enhancement (*correct[ing]*) is controlled by vertical limiter 47 (*a controller*), which provides letterbox control signal L to the *correctors* to indicate which portions of the image (*video signal*) are picture areas and therefore should be enhanced (*controls the correctors to cause the correctors to correct the video signal*). *Id.*, 13:64-14:1; *see also* §§IV.C-E (constructions of this claim element).

7. [5.e.ii] (“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.”)

152. Fujimura combined with Kim discloses this claim element.

153. “The no-picture areas” of this element refers to the “no-picture areas having a single color” of element 5.c. Thus, when *pattern portions* include more

than a single color, *the pattern portions are not the no-picture areas*. Kim discloses such *pattern portions*. Kim discloses that a video image can include a “pattern-like image,” such as the “pattern-like image” shown in its Figure 1 (below). EX1004, ¶39, ¶1.



Kim distinguishes a “pattern-like image” from “a normal image,” and its pattern-like images therefore each are a *pattern portion other than contents* (as required by element 5.b). *Id.*, ¶39, ¶1 (“normal images (not pattern-like images)”). Kim’s “pattern-like image” of Figure 1 includes more than a single color because it includes at least two colors (black and white), as shown above. Kim likewise discloses a “pattern-like image” that results in the histogram of Figure 2, which indicates at least two colors. *Id.*, ¶32, Fig. 2 (large histogram values at certain

gradation levels), ¶22 (gradation varies from 0 (black) to L (white)). Because these pattern-like images include more than a single color, they are *pattern portions [that] are not the no-picture areas*.

154. Kim further discloses detecting such pattern-like images using its “calculation device 34” which calculates the parameter “r,” as described for element 1.b in Ground 1. If r equals 1, the image is a “pattern-like image.” EX1004, ¶43. In that case, Kim’s mixer 36 (a *corrector*) and its mixer 36 combined with image enhancer 32 (also a *corrector*) do not correct the video image (*video signal*), as described for elements 1.c and 1.d in Ground 1. Kim’s calculation device 34 and the communication channel that provides r to mixer 36 therefore collectively are a *controller* (recited in element 5.e.i) that *controls* mixer 36 (at least part of a *corrector*) to *cause the corrector not to correct* the video image (the *video signal* of this claim) when the image is one of the pattern-like images described above (*when the pattern portions are not the no-picture areas*). See also Ground 1, element 1.d; §§IV.D-E (constructions of this claim element).

a. Combining Fujimura and Kim.

155. In my opinion, it would have been obvious to a POSITA to combine with Fujimura the Kim functionality cited above. A POSITA could have done so by, for example, adding to Fujimura Kim’s “calculation device 34” (described for element 1.b in Ground 1) and “mixer 36” (described for elements 1.c and 1.d in

Ground 1). A POSITA could have incorporated them into Fujimura by, for example, using mixer 36 to not correct the video image if calculation device 34 detects a pattern portion (as Kim discloses and as described above), except when the pattern portion is detected to be a no-picture area having a single color (as Fujimura discloses and as described for element 5.e.i), in which case Fujimura would correct the picture area (as Fujimura discloses and as described for element 5.e.i).

156. Doing so would have been within the skill and knowledge of a POSITA, as confirmed by Kim and Fujimura. Doing so also would have led to predictable results, would have created a reasonable expectation of success, and would have been compatible with Fujimura. For example, Fujimura's disclosed functionality of correcting only the picture area when the video image includes black non-picture bands (letterbox bands) (described for element 5.e.i) would be unchanged. Doing so also would have been a mere design choice, consisting of adding Kim's video processing design (described above) to Fujimura's video processing design in a straightforward manner.

157. Motivation to do so arises from various places. Motivation first arises from Kim's disclosure that "pattern-like images," such as the one shown in its Figure 1, "will introduce unwanted or undesirable results," such as "unnatural and undesirable artifacts." EX1004, ¶1. This disclosure would have led a POSITA to

add Kim's functionality cited above to Fujimura to account for such pattern images. Although Fujimura discloses detecting letterbox video signals such as by decoding the video signal's "ID code," as described for element 5.c, the pattern image of Kim's ¶1 (and similar patterns) are not letterbox patterns and therefore would not be detected by Fujimura's letterbox signal detector. *Compare* EX1004, Fig. 1 *with* EX1005, Fig. 18. Thus, a POSITA would have been motivated to add Kim's functionality to Fujimura to account for such patterns for which Fujimura does not account.

158. Additional motivation arises from Fujimura, which discloses accounting for pattern portions in video when performing contrast enhancement and not performing such enhancement on the pattern portions. EX1005, 1:51-55, 14:50-59. This would have encouraged a POSITA to add Kim's functionality to Fujimura to further implement this teaching by accounting for additional pattern portions in a video and not performing contrast enhancement on them, as Kim discloses, and as described above.

B. Claim 6

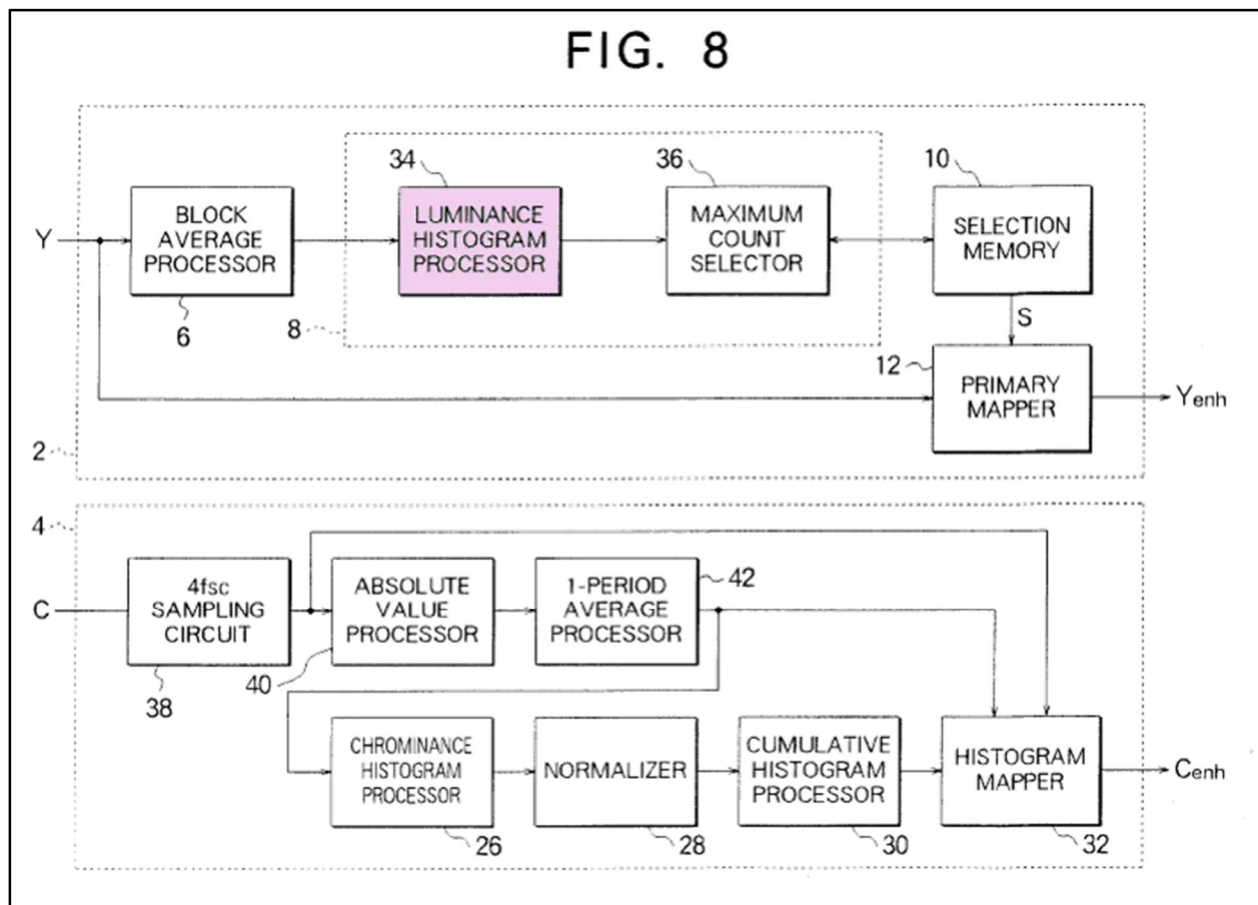
159. Fujimura combined with Kim discloses claim 6.

2. [6.pre] ("The video processing apparatus according to claim 5, comprising:")

160. Fujimura combined with Kim discloses this preamble. *See* claim 5.

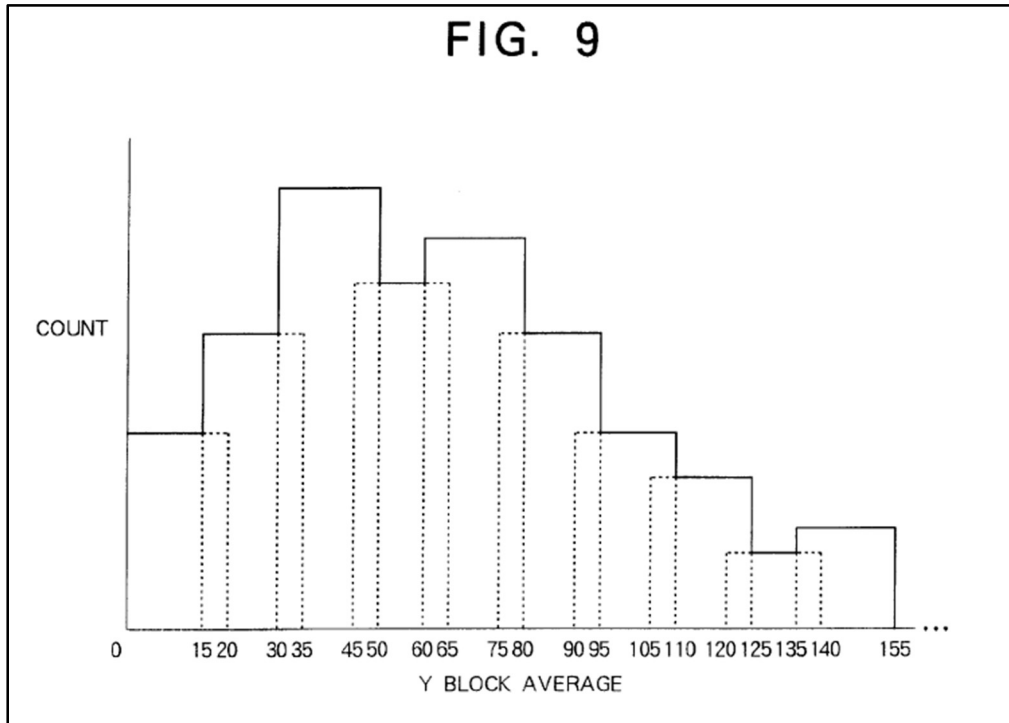
3. [6.a] (“a characteristic point detector which detects a level or distribution of at least one of luminance, hue and saturation of the video signal,”)

161. Fujimura discloses this claim element. Fujimura discloses that luminance contrast enhancer 2 includes a “luminance histogram processor 34” (*a characteristic point detector*), annotated below in purple. EX1005, 8:56-67, Fig. 8.



Luminance histogram processor 34 receives from “block average processor 6” the “mean luminance level of all the pixels” in the image. *Id.*, 9:10-13, 4:13-39, Fig. 2 (example blocks in an image). It uses this data to “construct[] a histogram of the

mean [luminance] values” for each image (*video signal*). *Id.*, 9:10-13. Figure 9 shows an example of such a histogram. *Id.*, 9:13-14.



The histogram’s horizontal axis represents “a plurality of overlapping luminance ranges in which the mean levels may fall,” and the vertical axis represents “the number of blocks with mean luminance levels in each range.” *Id.*, 9:13-17, 4:26-27 (all images are divided into blocks), Fig. 2 (example blocks). The count for each range in the histogram therefore *detects a level of luminance of the image (video signal)*, and the histogram as a whole *detects a distribution of luminance of the image (video signal)*. Luminance histogram processor 34 therefore also is a *characteristic point detector that detects a level and distribution of luminance of the video signal*. See also §IV.F (construction of “characteristic point detector”).

162. If this claim element is construed as a means-plus-function claim element with corresponding structure of a picture quality enhancement circuit and its equivalents (EX1001, Figs. 1-2, 5:23-24), Fujimura discloses and renders obvious such a structure. Fujimura discloses that luminance histogram processor 34 is a processor, which would be a picture quality enhancement circuit or its equivalent because its disclosed purpose is for use in picture quality enhancement (*i.e.*, luminance contrast enhancement and chrominance contrast enhancement). EX1005, 9:10-17. It also would have been obvious to a POSITA to implement luminance histogram processor 34 in such a circuit or its equivalent. Motivation to do so arises from Fujimura's disclosure that luminance contrast enhancer (of which luminance histogram processor is part) may be implemented in "a general-purpose processor such as a digital signal processor." EX1005, 3:63-4:11, Fig. 8, 8:56-60.

4. [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.")

163. Fujimura discloses this claim element. As described for element 5.c, Fujimura discloses that letterbox signal detector 46 (a *no-picture area detector*) *detects that the pattern portions are black non-picture bands (no-picture areas)* above and below the picture area.

164. Fujimura also discloses that, after letterbox signal detector 46 outputs

a pair of line numbers specifying the starting and ending lines of the picture area in the image (*the no-picture area detector has detected that the pattern portions are no-picture areas*), the “construction of histograms [is] restricted to the area between the starting and ending lines of the picture area, including the starting line but not the ending line.” EX1005, 14:46-56. The “ending line” of this passage is the first line of the bottom black band. *Id.*, 14:25-36. Thus, the construction of the histogram by the luminance histogram processor 34 (*a characteristic point detector*) considers only the image’s picture area and not its black bands (*the video signal other than the no-picture areas*). And, as described for element 6.a, the histogram *detects a level and distribution of luminance of this area*.

C. Claim 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.”)

165. Fujimura discloses claim 7. *See* Ground 2, claim 4.

D. Claim 8 (“The video processing apparatus according to claim 5, wherein the no-picture areas have a black color or a white color.”)

166. Fujimura discloses claim 8. *See* Ground 2, element 1.b; Ground 2, claim 4 (*the no-picture areas have a black color*).

* * *

167. If Patent Owner argues the portions of Fujimura or Kim cited above relate to different, incompatible embodiments (which they do not), it would have been obvious to a POSITA to combine such embodiments into a single system at

least because such embodiments are described in the same prior art reference, are fully compatible with each other, and could be combined with minimal effort to achieve predictable results.

168. If Patent Owner argues that Fujimura or Kim does not disclose any element of the challenged claims, such element would have nonetheless been obvious to a POSITA in light of Fujimura and Kim. Practicing any element of the challenged claims in light of Fujimura and Kim would have been within the knowledge and skill of a POSITA, would have required minimal effort, would have yielded predictable results, would have been fully compatible with Fujimura, and would have been a mere design choice. Motivation to do so arises from at least common sense and the disclosures of Fujimura and Kim set forth above.

IX. CONCLUSION

169. For these reasons, it is my opinion that the claims of the '645 patent are unpatentable.

APPENDIX A

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B. PROFESSIONAL BIOGRAPHY

Dr. Schonfeld received the B.S. degree in Electrical Engineering and Computer Science from the University of California, Berkeley, California, and the M.S. and Ph.D. degrees in Electrical and Computer Engineering from The Johns Hopkins University, Baltimore, Maryland, in 1986, 1988, and 1990, respectively.

In August 1990, he joined the Department of Electrical Engineering and Computer Science at the University of Illinois Chicago, Illinois, where he is Professor Emeritus in the Departments of Electrical and Computer Engineering, Computer Science, and Biomedical Engineering. He has also served as Director of the University-Industry Engineering Research Center (UIERC), also known as the Manufacturing Research Center (MRC). He is also Co-Director of the Multimedia Communications Laboratory (MCL) and member of the Signal and Image Research Laboratory (SIRL).

Dr. Schonfeld has been elevated to the rank of Fellow of the IEEE “for contributions to image and video analysis.” He was also elevated to the rank of Fellow of the SPIE “for specific achievements in morphological image processing and video analysis.” Dr. Schonfeld has been elected University Scholar of the University of Illinois and received the Graduate Mentoring Award of the University of Illinois Chicago.

Dr. Schonfeld has authored over 250 technical papers in various journals and conferences. He was co-author (with Carlo Giuliatti and Rashid Ansari) of a paper that won the Best Paper Award at the ACM Multimedia Workshop on Advanced Video Streaming Techniques for Peer-to-Peer Networks and Social Networking 2010. He was also co-author (with Junlan Yang) of a paper that won the Best Student Paper Award in the IEEE International Conference on Image Processing 2007. He was also co-author (with Wei Qu) of a paper that won the Best Student Paper Award in the IEEE International Conference on Image Processing 2006. He was also co-author (with Nidhal Bouaynaya) of a paper that won the Best Student Paper Award in Visual Communication and Image Processing 2006.

Dr. Schonfeld has served as Editor-in-Chief of the IEEE Transactions on Circuits and Systems for Video Technology. He has also served as Deputy Editor-in-Chief of the IEEE Transactions on Circuits and Systems for Video Technology as well as Area Editor for Special Issues of the IEEE Signal Processing Magazine. He has also served as Associate Editor of the IEEE Transactions on Image Processing (on image and video storage, retrieval and analysis), Associate Editor of the IEEE Transactions on Circuits and Systems for Video Technology (on video analysis), Associate Editor of the IEEE Transactions on Signal Processing (on multidimensional signal processing and multimedia signal processing), and Associate Editor of the IEEE Transactions on Image Processing (on nonlinear filtering). He has also served on the editorial board of various journal publications. He has also served as guest editor for numerous special issues in various journal publications.

Dr. Schonfeld has served on the Conference Board of the IEEE Signal Processing Society. He has also served as Technical Program Chair of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2018. He was also organizer of the Thematic Symposium on Multimedia Search and Retrieval at the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2009. He has also served as General Chair of the International Conference on Internet Multimedia Computing and Service (ICIMCS) 2018, the IEEE Conference on Visual Communication and Image Processing (VCIP) 2016, the Workshop on Big Data in 3D Computer Vision 2013, and the IEEE International Conference on Multimedia and Expo (ICME) 2012. He has also served as Program Chair of the IEEE Conference on Visual Communication and Image Processing (VCIP) 2015. He has also served as Technical Program Chair of the IEEE Workshop on Genomic Signal Processing and Statistics (GENSIPS) 2009 as well as Chair of the Workshop on Video Mining 2008. He has also served as Chair of the SPIE Conference on Visual Communication and Image Processing (VCIP) 2007. He was a member of the organizing committees of the

IEEE International Conference on Image Processing (ICIP) 1998, 2012, 2018, and 2020, IEEE/SPIE International Conference on Visual Communications and Image Processing (VCIP) 2007, 2010, 2015, 2016, and 2017, and IEEE Workshop on Nonlinear Signal and Image Processing (NSIP) 1997.

Dr. Schonfeld was keynote speaker at the N-Brain Alliance Launch & Product Release Conference 2018 as well as Think for Education Conference (TEC) AI+Education 2018. He was also keynote speaker at the International Conference on Wireless Communications and Signal Processing (WCSP) 2016. He was also keynote speaker at the International Conference on Intelligent Control and Information Processing (ICICIP) 2013 and International Conference on Brain Inspired Cognitive Systems (BICS) 2013. He was also plenary speaker at the IEEE/IET International Conference on Audio, Language and Image Processing (ICALIP), Shanghai, China, in 2010. He was also plenary speaker at the IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS), Genoa, Italy, in 2009. He was also plenary speaker at the INPT/ASME International Conference on Communications, Signals, and Systems (ICCSS), Rabat Morocco, in 1995 and 2001.

Dr. Schonfeld has served as Representative of Regions 1-6 (North America) in the Chapters Committee of the IEEE Signal Processing Society. He has also served as Chairman of the Chicago Chapter of the IEEE Signal Processing Society. He is currently serving on the IEEE Multimedia Communications Technical Committee and IEEE Visual Signal Processing and Communications (VSPC) Technical Committee. He has also served on the IEEE Image, Video, and Multidimensional Signal Processing (IVMSP) Technical Committee, formerly the IEEE Image and Multidimensional Signal Processing (IMDSP) Technical Committee. He also served on the American National Standards Institute (ANSI) / Underwriters Laboratory (UL) Standards Technical Panel ("STP") on Multimedia Systems.

Dr. Schonfeld serves as President of the Schonfeld Consulting Corporation, a company focused on technical support in computer science and engineering. Dr. Schonfeld has served as a consultant and expert witness for various companies including Amazon, ARRIS, ASUS, Blackberry, Bloomberg, Broadcom, Cablevision, Cisco, Cloudflare, Dell, DISH Network, Dolby, GE, Google, GoPro, Hewlett-Packard, Huawei, Intel, Lenovo, LG Electronics, MediaTek, Microsoft, Motorola, Netflix, NVIDIA, Panasonic, Polycom, Qualcomm, Samsung, TASER, Time Warner, TiVo, Vizio, Zeiss. His expertise are in the area of multimedia systems and signal processing and include various topics such as audio and video coding, audio processing, image and video analysis and processing, video-on-demand systems, multimedia communications, multimedia streaming, machine learning, etc.

His current research interests are in signal processing, image and video analysis, video retrieval and communications, multimedia systems, computer vision, machine learning, medical imaging, and genomic signal processing.

C. RESEARCH INTERESTS

Signal Processing, Image and Video Analysis, Video Retrieval and Communications, Multimedia Systems, Computer Vision, Machine Learning, Medical Imaging, and Genomic Signal Processing.

D. HONORS AND AWARDS

IAM Patent 1000 2015: The World's Leading Patent Practitioners
The Worlds Leading Patent Litigation Expert Witnesses

Fourth Edition
2015

Graduate Mentoring Award
University of Illinois Chicago
2014

University Scholar
University of Illinois
2010

Member
National Academy of Artificial Intelligence (NAAI)
2025

World's AI Top Scientist
International Artificial Intelligence Industry Alliance (AIIA)
2023

Fellow
Asia-Pacific Artificial Intelligence Association (AAIA)
2021

Fellow
International Society for Optics and Photonics (SPIE)
“For Specific Achievements in Morphological Image Processing and Video Analysis”
2011

Fellow
Institute of Electrical and Electronics Engineers (IEEE)
“For Contributions to Image and Video Analysis”
2010

Senior Member
Institute of Electrical and Electronics Engineers (IEEE)
2005

Best Paper Award
C. Giulietti, D. Schonfeld, and R. Ansari
“A Novel Cache Optimization Algorithm and Protocol
for Video Streaming in Pure Peer-to-Peer Networks”
ACM Multimedia Workshop on Advanced Video Streaming Techniques
for Peer-to-Peer Networks and Social Networking
2010

Best Student Paper Award
J. Yang, D. Schonfeld and M. Mohamed
“Robust Focused Image Estimation from Multiple Images in Video Sequences”
IEEE International Conference on Image Processing
2007

Best Student Paper Award

W. Qu and D. Schonfeld

“Robust Kernel-Based Tracking Using Optimal Control”

IEEE International Conference on Image Processing

2006

Best Student Paper Award

N. Bouaynaya and D. Schonfeld

“Spatially-variant morphological image processing: Theory and applications”

SPIE Conference on Visual Communications and Image Processing

2006

Advising Award

College of Engineering

University of Illinois Chicago

2013

Outstanding Associate Editor Award – IEEE Circuits and Systems Society

IEEE Circuits and Systems Society

IEEE Transactions on Circuits and Systems for Video Technology

2009

Most Active Chapter Award – IEEE Signal Processing Chicago Chapter Chair

IEEE – Region 4

2008

Service Award – IEEE Signal Processing Chicago Chapter Chair

IEEE – Chicago Section

2007

Certificate of Felicitation – Techo India University

“In recognition of your stellar contribution in the field of Electrical Engineering & Computer Science”

Kolkata, West Bengal, India

2023

Certificate of Appreciation – UL Standards & Engagement

Technical Committee Member

2004 – 2024

Certificate of Appreciation – IEEE Signal Processing Society

Chair, IEEE Signal Processing Chapter

Chicago Section

2006 – 2012

Certificate of Appreciation – IEEE Circuits and Systems Society

IEEE Circuits and Systems Society

Prize Paper Award Subcommittee

2010

Certificate of Appreciation – IEEE Circuits and Systems Society

IEEE Circuits and Systems Society
Deputy Editor-in-Chief of the IEEE Transactions on Circuits and Systems for Video Technology
2008 – 2010

Certificate of Appreciation – IEEE Circuits and Systems Society

IEEE Circuits and Systems Society
Associate Editor of the IEEE Transactions on Circuits and Systems for Video Technology
2008 – 2010

Certificate of Appreciation – IEEE Signal Processing Chicago Chapter Chair

IEEE – Chicago Section
2006

Top Reviewer Recognition Certificate

IEEE International Conference on Image Processing (ICIP)
Abu Dhabi, United Arab Emirates
2020

**2018 Albert Nelson Marquis Lifetime Achievement Award
Marquis Who's Who**

Who's Who in the World
2021 Edition

Who's Who in the World
2020 Edition

Who's Who in the World
2019 Edition

Who's Who in the World
2018 Edition

Worldwide Who's Who
2014 Edition

Who's Who in America (WWA)
2019 Edition

Who's Who in America (WWA)
2012 Edition

Who's Who in America (WWA)
2011 Edition

Who's Who in America (WWA)
2010 Edition

Who's Who in Engineering Education (WWE)
2002 Edition

University Fellowship
The Johns Hopkins University
1986—1990

E. IN THE NEWS

IEEE Fellow Dan Schonfeld: Helping Catch Thieves & Read Fuzzy Faxes

e-Scanfax: IEEE Chicago Section Newsletter

January 2010

<http://www.ieeechicago.org/LinkClick.aspx?fileticket=Py81tdr4GTM%3D&tabid=390&mid=884>

IEEE-Chicago Fellows Provide Words of Wisdom to New IEEE Members

e-Scanfax: IEEE Chicago Section Newsletter

May 2010

http://www.ieeechicago.org/LinkClick.aspx?fileticket=2GIDPZnZQ_M%3D&tabid=390&mid=884

What You See, What You Get

University Scholar Dan Schonfeld

Paul Francuch

UIC News

November 10, 2010

<http://www.uic.edu/htbin/cgiwrap/bin/uicnews/articledetail.cgi?id=14769>

Genomic Signal Processing May Yield Clues to Cancer Treatment

Paul Francuch

UIC News Release

November 17, 2010

[http://tiger.uic.edu/htbin/cgiwrap/bin/newsbureau/cgi-bin/index.cgi?
from=Releases&to=Release&id=3073&start=1232172000&end=1329285600&topic=2&dept=64](http://tiger.uic.edu/htbin/cgiwrap/bin/newsbureau/cgi-bin/index.cgi?from=Releases&to=Release&id=3073&start=1232172000&end=1329285600&topic=2&dept=64)

New Camera Focuses Photos After They Are Taken

Morgen Peck

InnovationNewsDaily Contributor

November 4, 2011

<http://www.innovationnewsdaily.com/camera-focuses-photos-after-2358/>

F. EDUCATION

Ph.D. July 1990

The Johns Hopkins University

Department of Electrical & Computer Engineering

Concentration: Nonlinear Signal Processing / Image Analysis

Thesis Title: “Optimal Morphological Representation and Restoration of Binary Images:
Theory and Applications”

First Reader: Prof. John Goutsias; Second Reader: Prof. Victor Solo

M.S. May 1988

The Johns Hopkins University
Department of Electrical & Computer Engineering
Concentration: Speech Processing / Biomedical Signal Processing
Advisor: Prof. Moise H. Goldstein

B.S. May 1986
University of California at Berkeley
Department of Electrical Engineering & Computer Science
Concentration: Computer Engineering / Systems Engineering
Advisor: Prof. Michael J. Sabin

G. WORK EXPERIENCE

Professor Emeritus
Department of Electrical & Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2024—Present

Director
Manufacturing Research Center (MRC)
University-Industry Engineering Research Center (UIERC)
College of Engineering
University of Illinois Chicago
Chicago, Illinois
2008—2011

Professor with Tenure
Department of Electrical & Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2007—Present

Professor (Courtesy Appointment)
Department of Computer Science
University of Illinois Chicago
Chicago, Illinois
2007— 2025

Professor
Department of Biomedical Engineering
University of Illinois Chicago
Chicago, Illinois
2021— Present

Professor
Department of Bioengineering
University of Illinois Chicago
Chicago, Illinois

2007— 2021

Associate Professor with Tenure

Department of Electrical & Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2001—2007

Associate Professor (Courtesy Appointment)

Department of Computer Science
University of Illinois Chicago
Chicago, Illinois
2001—2007

Associate Professor

Department of Bioengineering
University of Illinois Chicago
Chicago, Illinois
1998—2007

Associate Professor with Tenure

Department of Electrical Engineering & Computer Science
University of Illinois Chicago
Chicago, Illinois
1996—2001

Co-Director

Multimedia Communications Laboratory (MCL)
Department of Electrical & Computer Engineering
University of Illinois Chicago
Chicago, Illinois
1997—Present

Assistant Professor

Department of Electrical Engineering & Computer Science
University of Illinois Chicago
Chicago, Illinois
1990—1996

Member

Signal and Image Research Laboratory (SIRL)
Department of Electrical & Computer Engineering
University of Illinois Chicago
Chicago, Illinois
1990—2002

Instructor

Department of Electrical and Computer Engineering
The Johns Hopkins University
Baltimore, Maryland
1987—1990

Teaching Assistant

Department of Electrical and Computer Engineering
The Johns Hopkins University
Baltimore, Maryland
1986—1990

Software Engineer

Computer Aided Design
Teledyne Systems
Northridge, California
Summer 1984—85—86

H. CONSULTING EXPERIENCE

Consultant & Expert Witness

2001—Present

Consulting Activities:

Deposition and Trial Testimony
Patent Litigation
Copyright Litigation
Trade Secret Litigation
International Trade Litigation
Customs Litigation
Contract Litigation

Areas of Expertise:

Multimedia Systems
Multimedia Retrieval, Storage, and Communication Systems
Image and Video Processing
Signal Processing and Communications

Examples of Previous Litigation Experience:

Audio Coding Systems
Audio Compression Systems
Audio Processing Systems
Cable Systems
Camera Systems
Deep Learning
Graphics Processors
Image Coding Systems
Image Compression Systems
Image Processing Systems
Internet Advertising
Internet Streaming
Jukebox Systems
Machine Learning
Medical Imaging

Neural Networks
Signal Processing
Smartphones and Tablets
Television Systems
Video-on Demand (VoD) Systems
Video Coding Systems
Video Compression Systems
Video Processing Systems
Video Storage Systems
Video Streaming Systems
Wireless Systems

Companies:

Served as a consultant and expert witness for various companies including Amazon, ARRIS, ASUS, Blackberry, Bloomberg, Broadcom, Cablevision, Cisco, Cloudflare, Dell, DISH Network, Dolby, GE, Google, GoPro, Hewlett-Packard, Huawei, Intel, Lenovo, LG Electronics, MediaTek, Microsoft, Motorola, Netflix, NVIDIA, Panasonic, Polycom, Qualcomm, Samsung, TASER, Time Warner, TiVo, Vizio, Zeiss.

Consultant & President

Schonfeld Consulting Corporation
Multimedia Systems
Northbrook, Illinois
2017—Present

Consultant & President

Multimedia Systems Corporation
Multimedia Systems
Glenview, Illinois
2002—2005

Consultant

Chicago Mercantile Exchange
Multimedia Communication Networks
Chicago, Illinois
1998

Consultant

PrairieComm Corp.
Multimedia Wireless Networks
Arlington Heights, Illinois
1997

I. VISITING POSITIONS

Distinguished Visiting Scholar

Advanced Analytics Institute (AAI)
University of Technology
Sydney, Australia

2012

Visiting Professor

Department of Information Engineering and Computer Science - DISI
University of Trento
Trento, Italy
May 2010

Visiting Professor

School of Computer Engineering
Nanyang Technological University
Singapore
July 2009

Visiting Associate Professor

Department of Electrical Engineering—Systems
Tel-Aviv University
Tel-Aviv, Israel
December 1996—January 1997

J. INTERDISCIPLINARY PROGRAMS

Collaborative Neuroimaging Environment for Connectomics (CoNECT)

University of Illinois Chicago
2013—Present

Clinical and Translational Science (CCTS)

Biomedical Informatics Core Consult Group
University of Illinois Chicago
2009—Present

Graduate Program in Neuroscience

University of Illinois Chicago
2001—Present

Bioinformatics Program

Department of Bioengineering
University of Illinois Chicago
2000—Present

K. PROFESSIONAL ACTIVITIES

K.1. Editorships

Editor-in-Chief (EIC)

IEEE Transactions on Circuits and Systems for Video Technology
2014—2017

Deputy Editor-in-Chief (DEIC)

IEEE Transactions on Circuits and Systems for Video Technology
2010—2013

Area Editor, Special Sections

Special Issues
IEEE Signal Processing Magazine
2009—2011

Editor

Video Search and Mining
Studies in Computational Intelligence Series
Springer-Verlag
2009

Associate Editor

IEEE Transactions on Image Processing
Image and Video Storage, Retrieval and Analysis
2007—2009

Associate Editor

IEEE Transactions on Circuits and Systems for Video Technology
Video Analysis
2006—2009

Associate Editor

IEEE Transactions on Signal Processing
Multidimensional Signal Processing &
Multimedia Signal Processing
1999—2000

Associate Editor

IEEE Transactions on Image Processing
Filtering and Enhancement
1994—1996

Guest Editor

IEEE Journal of Special Topics in Signal Processing
Special Issue on Mathematical Morphology
and Its Applications to Image and Signal Processing
2011—2012

Guest Editor

IEEE Transactions on Image Processing
Special Issue on Distributed Camera Networks:
Sensing, Processing, Communication and Computing
2010—2011

Guest Editor

EURASIP Journal on Image and Video Processing

Special Issue on Advanced Video-Based Surveillance
2010—2011

Lead Guest Editor

IEEE Journal of Special Topics in Signal Processing
Special Issue on Recent Advances in Video Processing for Consumer Displays
2009—2011

Guest Editor

IEEE Transactions on Circuits and Systems for Video Technology
Special Issue on Event Analysis in Videos
2008

Lead Guest Editor

IEEE Journal of Special Topics in Signal Processing
Special Issue on Genomic and Proteomic Signal Processing
2007—2008

Guest Editor

Journal of Advances in Multimedia
Special Issue on Plenoptic Signal and Image Processing
2007—2008

Advisory Board

Bentham Books
Bentham Science
2021—Present

Editorial Board

Sensors
MDPI
2021—Present

Editorial Board

Recent Advances in Computer Science and Communications
Bentham Science Publishers, Ltd.
2012—2023

Editorial Board

Journal of Electrical and Computer Engineering
Hindawi Publishing Corporation
2009—2019

Editorial Board

EURASIP Journal of Image and Video Processing
2009—2013

Editorial Board

IEEE Signal Processing Magazine
2008—2011

Editorial Board

Research Letters in Signal Processing
Hindawi Publishing Corporation
2007—2009

Editorial Board

Recent Patents on Computer Science
Bentham Science Publishers, Ltd.
2007—2019

Editorial Board

Recent Patents on Electrical Engineering
Bentham Science Publishers, Ltd.
2007—2012

Contributor

Science and Technology: SPIE Newsroom
Electronic Imaging and Signal Processing
2005—2008

K.2. Committees**EIC Selection Standing Committee**

IEEE Circuits and Systems Society
2025 – Present

Official Nominator

VinFuture Prize
2024 – Present

Moving Picture, Audio and Data Coding by Artificial Intelligence (MPAI)

2020

MPEG Future

2020–Present

Ad-Hoc Committee of the Conferences Board on Flagship Conferences Future Strategy

IEEE Signal Processing Society
2020-2021

Ad-Hoc Committee on Multi-Scale Models at SPS Flagship Conferences

IEEE Signal Processing Society
2019-2020

IEEE Signal Processing (SPS) Liaison

IEEE Signal Processing Society
2019-2021

Conference Board

IEEE Signal Processing Society

2019-2020

Chair

Best Paper Award Committee
CSV T Best Paper Award
IEEE Circuits and Systems Society
2023

Award Committee

Association for Computing Machinery (ACM)
ACM Multimedia
2020

Best Paper Award Selection Committee

CSV T Best Paper Award
IEEE Circuits and Systems Society
2020—2021

Best Paper Award Selection Committee

CSV T Best Paper Award
IEEE Circuits and Systems Society
2019—2020

Best Paper Award Selection Committee

CSV T Best Paper Award
IEEE Circuits and Systems Society
2013

Steering Committee

International Association for Pattern Recognition (IAPR)
Discrete Geometry and Mathematical Morphology (DGMM)
2022—Present

Travel Grant Selection Committee

IEEE Signal Processing Society
IEEE International Conference on Image Processing
2011

Steering Committee

International Society of Mathematical Morphology (ISMM)
International Symposium on Mathematical Morphology (ISMM)
2011—Present

Advisory Committee

IEEE Circuits and Systems Society
Visual Signal Processing and Communication (VSPC) Technical Committee
IEEE Conference on Visual Communications and Image Processing (VCIP)
2010— Present

Steering Committee

SPIE and IEEE Circuits and Systems Society

Conference on Visual Communications and Image Processing
2008—2010

Scientific Advisory Board

World Congress of NeuroTalk
From Nervous Functions to Treatment
Singapore Expo, Singapore
2010

Chair

Nominations and Elections Subcommittee
Image, Video, and Multidimensional Signal Processing (IVMSP) Technical Committee
IEEE Signal Processing Society
2010— 2011

Honorable Member

Visual Signal Processing and Communications (VSPC) Technical Committee
IEEE Circuits and Systems Society
2018— Present

Member

Visual Signal Processing and Communications (VSPC) Technical Committee
IEEE Circuits and Systems Society
2015— 2019

Associate Member

Image, Video, and Multidimensional Signal Processing (IVMSP) Technical Committee
IEEE Signal Processing Society
2014— Present

Member

IEEE Multimedia Communications Technical Committee (MMTC) Technical Committee
IEEE Communications Society
2009— Present

Member

Image, Video, and Multidimensional Signal Processing (IVMSP) Technical Committee
IEEE Signal Processing Society
2009— 2012

Member

Image and Multidimensional Signal Processing (IMDSP) Technical Committee
IEEE Signal Processing Society
2007—2008

Member

Signal and Image Processing in Medicine Technical Committee
IEEE Circuits and Systems Society
1990—1996

Member

P2P Communication and Networking Technical Subcommittee
Multimedia Communications Technical Committee
IEEE Communications Society
2006—Present

Representative

Regions 1-6 (North America)
Chapters Committee
IEEE Signal Processing Society
2006—2012

Chairman

Chicago IEEE Signal Processing Chapter
2006—2012

Member

American National Standards Institute/Underwriters Laboratory (ANSI/UL)
Standards Technical Panels (STP)

STP 1309: Marine Shipboard Cable

UL 1309: Standard for Marine Shipboard Cable
UL 1309A: Standard, Cable for Use in Mobile Installations

STP 1863: Communications-Circuit Accessories

UL 1863: Standard for Communications-Circuit Accessories

STP 6065: Audio, Video And Similar Electronic Apparatus - Safety Requirements

UL 150: Standard for Antenna Rotators
UL 452: Standard for Antenna – Discharge Units
UL 469: Standard for Musical Instruments and Accessories
UL 813: Standard for Commercial Audio Equipment
UL 1412: Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances
UL 1413: Standard for High-Voltage Components for Television-Type Appliances
UL 1416: Standard for Overcurrent and Overtemperature Protectors for Radio- and Television-Type Appliances
UL 1417: Standard for Special Fuses for Radio- and Television-Type Appliances
UL 1492: Audio/Video Products and Accessories
UL 1676: Standard for Conductive-Path and Discharge-Path Resistors for Use in Radio-, Video-, or Television-Type Appliances
UL 6500: Standard for Audio/Video and Musical Instrument Apparatus for Household, Commercial, and Similar General Use
UL 60065: Standard for Audio, Video and Similar Electronic Apparatus – Safety Requirements

STP 6268: Audio/Video, Information Technology, And Communication Technology Equipment

UL 62368: Audio/video, Information and Communication Technology Equipment

STP 9990: Information and Communication Technology (ICT) Cables

UL 9990: Standard for Safety for Information and Communication Technology (ICT) Power Cables

2002—Present

K.3. Review Panels

Member

Expert Panel
Faculty of Computing and Electrical Engineering
Tampere University of Technology (TUT)
Tampere, Finland
2011

Member

Paper Award Committee
IEEE International Conference on Advanced Video and Signal-Based Surveillance (AVSS)
Genoa, Italy
2009

Member

Technical Jury
NTT DoCoMo USA Labs Most Innovative Paper Awards
IEEE International Conference on Image Processing
San Diego, California
2008

Member

Technical Jury
NTT DoCoMo USA Labs Most Innovative Paper Awards
IEEE International Conference on Image Processing
San Antonio, Texas
2007

Member

Technical Jury
NTT DoCoMo USA Labs Most Innovative Paper Awards
IEEE International Conference on Image Processing
Atlanta, Georgia
2006

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Computing and Communication Foundations (CCF)
Image and Multi-Dimensional Signal Processing (IMDSP)
2015

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Computing and Communication Foundations (CCF)
Communications and Information Foundations (CIF)
2012

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Computing and Communication Foundations (CCF)
Communications and Information Foundations (CIF)
2011

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Information & Intelligent Systems (IIS)
Databases and Data Mining (DB/DM)
2007

Member

NSF Review Panel
Small Business Innovation Research (SBIR) Program
Robotics II
Phase II
2007

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Information & Intelligent Systems (IIS)
Information Management (IM)
2006

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Information & Intelligent Systems (IIS)
Information & Knowledge Management (IKM)
2005

Member

NSF Review Panel
Small Business Innovation Research (SBIR) Program
Robotics II
Phase I
2005

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Advanced Networking Infrastructure and Research (ANIR)
Information Technology Research (ITR)
Networking Research
Small Grants
2002

Member

NSF Review Panel
Small Business Innovation Research (SBIR) Program
Diagnostic Systems and Signal Processing
Phase I
2002

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Information Technology Research (ITR)
Biology & Information Technology
Computational Biology / Biocomputation
Medium Grants
2003

K.4. Conference Chair

General Chair

International Conference on Internet Multimedia Computing and Service (ICIMCS)
Nanjing, China
2018

Technical Program Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)
Calgary, Canada
2018

General Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
Chengdu, China
2016

Program Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
Singapore
2015

General Co-Chair

Workshop on Big Data in 3D Computer Vision
Held in conjunction with the IEEE International Conference on Computer Vision (ICCV)
Melbourne, Australia
2013

General Co-Chair

IEEE International Conference on Multimedia and Expo (ICME)
Melbourne, Australia
2012

Technical Program Chair

IEEE International Workshop on Genomic Signal Processing and Statistics (GENSIPS)
Minneapolis, Minnesota
2009

Chair

Workshop on Video Mining
IEEE International Conference on Data Mining
Held in conjunction with the IEEE International Conference on Data Mining (ICDM)
Pisa, Italy
2008

Chair

SPIE International Conference on Visual Communications and Image Processing (VCIP)
San Jose, California
2007

Multimedia Content Analysis Track Chair

IEEE International Conference on Multimedia and Expo
New York, New York
2009

Technical Program Committee / Area Chair

IEEE International Conference on Image Processing
San Diego, California
2008

Technical Program Committee / Area Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Las Vegas, Nevada
2008

Technical Program Committee / Area Chair

IEEE International Conference on Image Processing
San Antonio, Texas
2007

Associate Program Chair

ACM Multimedia
Juan Les Pins, France
2002

K.5. Organizing Committees

Special Sessions Co-Chair

IEEE International Conference on Image Processing (ICIP)
Abu Dhabi, United Arab Emirates
2024

Special Sessions Co-Chair

IEEE International Conference on Image Processing (ICIP)

Abu Dhabi, United Arab Emirates
2020

Technical Program Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)
Calgary, Canada
2018

Plenary Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
St. Petersburg, Florida
2017

General Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
Chengdu, China
2016

Program Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
Singapore
2015

General Co-Chair

Workshop on Big Data in 3D Computer Vision
Held in conjunction with the IEEE International Conference on Computer Vision (ICCV)
Melbourne, Australia
2013

General Co-Chair

IEEE International Conference on Multimedia and Expo (ICME)
Melbourne, Australia
2012

Plenary Chair

IEEE International Conference on Image Processing (ICIP)
Orlando, Florida
2012

Publications Chair

IEEE Conference on Advanced Video and Signal-based Surveillance (AVSS)
Beijing, China
2012

USA Liaison Chair

IEEE Conference on Advanced Video and Signal-based Surveillance (AVSS)
Klagenfurt, Austria
2011

Publicity Co-Chair

IEEE/SPIE International Conference on Visual Communications and Image Processing (VCIP)

Huang Shan, An Hui, China
2010

Technical Program Chair

IEEE International Workshop on Genomic Signal Processing and Statistics (GENSIPS)
Minneapolis, Minnesota
2009

Organizer

IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)
Thematic Symposium on Multimedia Search and Retrieval
Taipei, Taiwan
2009

Chair

Workshop on Video Mining
Held in conjunction with the IEEE International Conference on Data Mining (ICDM)
Pisa, Italy
2008

Chair

SPIE International Conference on Visual Communications and Image Processing (VCIP)
San Jose, California
2007

Technical Organizing Committee

IS&T/SPIE Annual Symposium on Electronic Imaging: Science and Technology
San Jose, California
2007

Publications Chair

IEEE International Conference on Image Processing
Chicago, Illinois
1998

Plenary Talks and Special Session Chair

IEEE/EURASIP Workshop on Nonlinear Signal and Image Processing
Mackinac Island, Michigan
1997

K.6. Technical Program Committees

Technical Program Committee

SPIE Conference on Video Surveillance and Transportation Imaging
San Francisco, California
2015

Technical Program Committee

SPIE Conference on Video Surveillance and Transportation Imaging
San Francisco, California

2014

Program Committee

IEEE International Conference on Automatic Face and Gesture Recognition (FG 2013)
Shanghai, China
2013

Technical Program Committee

SPIE Conference on Video Surveillance and Transportation Imaging
San Francisco, California
2013

Technical Program Committee

SPIE Conference on Visual Information Processing and Communication
San Francisco, California
2013

Technical Program Committee

ICST International Conference on
Wireless Mobile Communication and Healthcare (MobiHealth)
Paris, France
2012

Technical Program Committee

SPIE Conference on Visual Information Processing and Communication
San Francisco, California
2012

Program Committee

International Workshop on Video Event Categorization, Tagging and Retrieval (VECTaR)
Held in conjunction with the International Conference on Computer Vision
Barcelona, Spain
2011

Technical Program Committee

ICST International Conference on
Wireless Mobile Communication and Healthcare (MobiHealth)
Kos Island, Greece
2011

Technical Program Committee

SPIE Conference on Visual Information Processing and Communication
San Francisco, California
2011

Technical Program Committee

IEEE International Workshop on Genomic Signal Processing and Statistics
Cold Spring Harbor Laboratory, New York
2010

Technical Program Committee

IEEE International Conference on Multimedia and Expo (ICME)
Singapore
2010

Technical Program Committee
International Conference on Pattern Recognition (ICPR)
Track I: Computer Vision
Istanbul, Turkey
2010

Technical Program Committee
ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC)
Atlanta, Georgia
2010

Technical Program Committee
IEEE Workshop on Multimedia Computing and Communications (MCC)
Held in conjunction with the International Conference on Computer Communications and Networks (ICCCN)
Zurich, Switzerland
2010

Program Committee
ACM International Conference on Bioinformatics and Computational Biology (ACM-BCB)
Niagara Falls, New York
2010

Technical Program Committee
IEEE/SPIE International Conference on Visual Communications and Image Processing
Huang Shan, An Hui, China
2010

Technical Program Committee
ICST International Conference on
Wireless Mobile Communication and Healthcare (MobiHealth)
Ayia Napa, Cyprus
2010

Technical Program Committee
SPIE International Conference on Visual Information Processing and Communications
San Jose, California
2010

Program Committee
International Workshop on Video Event Categorization, Tagging and Retrieval (VECTaR)
Held in conjunction with the Asian Conference on Computer Vision
Xi'an, China
2009

Program Committee
IEEE International Workshop on Video-Oriented Object and Event Classification (VOEC)

Held in conjunction with the International Conference on Computer Vision (ICCV)
Kyoto, Japan
2009

Program Committee / Reviewer
IEEE International Conference on Computer Vision
Kyoto, Japan
2009

Technical Program Committee
IEEE International Conference on Advanced Video and Signal-Based Surveillance (AVSS)
Genoa, Italy
2009

Technical Program Committee
IEEE Workshop on Multimedia Computing and Communications (MCC)
Held in conjunction with the International Conference on Computer Communications and Networks (ICCCN)
San Francisco, California
2009

Technical Program Committee
International Conference on Image and Graphics
Xi'an, China
2009

Program Committee
International Conference on Advances in Multimedia (MMEDIA)
Colmar, France
2009

Technical Program Committee
IEEE International Workshop on Computational Advances
in Multi-Sensor Adaptive Processing (CAMSAP)
Dominican Republic
2009

Technical Program Committee
SPIE International Conference on Visual Communications and Image Processing
San Jose, California
2009

Technical Program Committee / Reviewer
IEEE International Conference on Image Processing
San Diego, California
2008

Program Committee
IEEE Conference on Computer Vision and Pattern Recognition
Anchorage, Alaska
2008

Technical Program Committee / Reviewer

IEEE International Conference on Acoustics, Speech, and Signal Processing
Las Vegas, Nevada
2008

Technical Program Committee

IEEE International Workshop on Genomic Signal Processing and Statistics
Phoenix, Arizona
2008

Technical Program Committee

International Workshop on Multimedia Analysis & Processing (IMAP)
U.S. Virgin Islands
2008

Technical Program Committee

SPIE International Conference on Visual Communications and Image Processing
San Jose, California
2008

Program Committee

IEEE International Conference on Computer Vision
Rio de Janeiro, Brazil
2007

Technical Program Committee / Reviewer

IEEE International Conference on Image Processing
San Antonio, Texas
2007

Technical Program Committee

IEEE International Workshop on Genomic Signal Processing and Statistics
Tuusula, Finland
2007

Technical Program Committee

SPIE International Conference on Visual Communications and Image Processing
San Jose, California
2007

Technical Program Committee

IEEE International Conference on Image Processing
Atlanta, Georgia
2006

Technical Program Committee

IEEE International Workshop on Genomic Signal Processing and Statistics
College Station, Texas
2006

Technical Program Committee

SPIE International Conference on Visual Communications and Image Processing
San Jose, California
2006

Technical Program Committee / Reviewer

IEEE International Conference on Acoustics, Speech, and Signal Processing
Toulouse, France
2006

Technical Program Committee

IEEE International Conference on Image Processing
Genova, Italy
2005

Technical Program Committee / Reviewer

IEEE International Conference on Acoustics, Speech, and Signal Processing
Philadelphia, Pennsylvania
2005

Technical Program Committee

IEEE International Conference on Image Processing
Singapore
2004

Technical Program Committee

IEEE International Conference on Image Processing
Barcelona, Spain
2003

Technical Program Committee

IEEE International Conference on Image Processing
Rochester, New York
2002

Technical Program Committee

IEEE International Conference on Image Processing
Thessaloniki, Greece
2001

Technical Program Committee

IEEE International Conference on Image Processing
Vancouver, Canada
2000

Technical Program Committee

IEEE International Conference on Image Processing
Kobe, Japan
1999

Technical Program Committee

IEEE International Conference on Image Processing
Chicago, Illinois
1998

Technical Program Committee
International Symposium on Mathematical Morphology
Amsterdam, The Netherlands
1998

Technical Program Committee
SPIE International Conference on Visual Communications and Image Processing
San Jose, California
1998

Technical Program Committee
SPIE International Conference on Visual Communications and Image Processing
San Jose, California
1997

Technical Program Committee
SPIE International Conference on Visual Communications and Image Processing
Orlando, Florida
1996

Technical Program Committee
IEEE International Conference on Image Processing
Austin, Texas
1994

Technical Program Committee
IEEE International Symposium on Circuits and Systems
Chicago, Illinois
1993

K.7. Session Organizer

Chair
IEEE International Conference on Image Processing
Special Session on Face Recognition II
Orlando, Florida
2012

Organizer and Chair
IEEE International Conference on Acoustics, Speech, and Signal Processing
Special Session on Video Search and Event Analysis
Taipei, Taiwan
2009

Organizer
Workshop on Global Multimedia Mobile Communications

University of Illinois Chicago
Chicago, Illinois
2005

Organizer and Chair

IEEE International Conference on Image Processing
Special Session on Nonlinear Filtering
Austin, Texas
1994

Organizer and Chair

IEEE International Symposium on Circuits and Systems
Special Session on Medical Image and Signal Processing
Singapore
1991

Organizer and Chair

Conference on Information Sciences and Systems
Session on Nonlinear Image and Signal Processing I
Baltimore, Maryland
1991

K.8. Session Chair

Chair

IEEE International Conference on Image Processing
Session on Defect Removal
Taipei, Taiwan
2019

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Stereoscopic and 3D Processing
Brighton, United Kingdom
2019

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Image and Video Indexing and Retrieval
Prague, Czech Republic
2011

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Image/Video Semantic Understanding
Dallas, Texas
2010

Chair

IEEE International Conference on Advanced Video and Signal-Based Surveillance (AVSS)

Session on Trajectory Analysis and Learning
Genoa, Italy
2009

Chair
IEEE International Conference on Multimedia and Expo
Session on Multimedia Content Analysis and Synthesis IV
New York, New York
2009

Chair
IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Stereoscopic and 3-D Processing
Taipei, Taiwan
2009

Chair
IEEE International Conference on Image Processing
Session on Enhancement and Denoising II
San Diego, California
2008

Chair
IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Restoration and Enhancement
Las Vegas, Nevada
2008

Chair
SPIE Electronic Imaging Conference on Visual Communications and Image Processing
Session on Image Processing
San Jose, California
2008

Chair
IEEE International Conference on Image Processing
Session on Image and Video Restoration and Enhancement I
San Antonio, Texas
2007

Chair
IEEE International Conference on Image Processing
Session on Image and Video Filtering
Atlanta, Georgia
2006

Chair
IEEE International Conference on Multimedia and Expo
Session on Media Signal Processing
Toronto, Canada
2006

Chair

IEEE International Conference on Multimedia and Expo
Session on Multimedia Database Applications
Toronto, Canada
2006

Chair

IEEE International Conference on Multimedia and Expo
Session on Peer-to-Peer Multimedia Streaming
Toronto, Canada
2006

Chair

SPIE Electronic Imaging Conference on Visual Communications and Image Processing
Session on Computer Vision
San Jose, California
2006

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Video Segmentation and Tracking
Philadelphia, Pennsylvania
2005

Chair

SPIE Electronic Imaging Conference on Image and Video Communications and Processing
Session on Selective Encryption for Image/Video
San Jose, California
2005

Chair

SPIE Electronic Imaging Conference on Image and Video Communications and Processing
Session on Object Tracking
San Jose, California
2005

Chair

INPT/ASME International Conference on Communications, Signals and Systems
Session on Signals and Data
Rabat, Morocco
2001

Chair

SPIE Conference on Multimedia Storage and Archiving Systems III
Session on Video Segmentation
Boston, Massachusetts
1998

Chair

IEEE International Conference on Image Processing

Session on Image Sequence Segmentation
Chicago, Illinois
1998

Chair
International Symposium on Mathematical Morphology
Session on Theory
Atlanta, Georgia
1996

Chair
INPT/ASME International Conference on Communications, Signals and Systems
Session on Signals and Data
Rabat, Morocco
1995

Chair
IEEE Workshop on Nonlinear Signal and Image Processing
Session on Mathematical Morphology and Fuzzy DSP
Neos Marmaras, Halkidiki, Greece
1995

Chair
IEEE International Conference on Image Processing
Session on Shape Representation and Image Modeling
Austin, Texas
1994

Chair
SPIE Conference on Visual Communications and Image Processing
Session on Mathematical Morphology
Boston, Massachusetts
1992

Chair
Conference on Information Sciences and Systems
Session on Signal Representation, Modeling, and Analysis
Baltimore, Maryland
1991

K.9. Panelist and Participant

Panelist
DOD Tri-Service Workshop on Stochastic Methods in Image Analysis
Session on Mathematical Morphology
U.S. Army Harry Diamond Laboratories
Adelphi, Maryland
1992

Participant

Institute for Mathematics and its Applications (IMA)
Workshop on Large Data Sets in Medical Informatics
Minneapolis, Minnesota
2011

Participant

NSF Workshop on Improving Domestic Student Participation
in Electrical and Computer Engineering Graduate Programs
University of Tennessee
Knoxville, Tennessee
2009

Participant

Workshop on Global Multimedia Mobile Communications
University of Illinois Chicago
Chicago, Illinois
2005

Participant

Workshop on Extraction of Visual Information by Biological and Non-Biological Systems
University of Illinois Chicago
Chicago, Illinois
2002

Participant

Workshop on Multimedia Information Systems
Capri, Italy
2001

Participant

NSF Advanced Networking Infrastructure Support
National Workshop on Developing Guidance
Research Competitiveness Program
Washington, D.C.
1999

Participant

Institute for Mathematics and its Applications (IMA)
Workshop on Applications and Theory of Random Sets
Minneapolis, Minnesota
1996

Panelist

VCIP 2015 Panel Discussion: What's Next in Visual Communications and Image Processing?
IEEE Conference on Visual Communications and Image Processing (VCIP)
Singapore
2015

K.10. Outreach Activities

Judge

Region 6 Science Fair Paper Session
Illinois Junior Academy of Science
Stevenson High School
Lincolnshire, Illinois
2022

Judge

State Science Fair Poster Session
Illinois Junior Academy of Science
Peoria Civic Center
Peoria, Illinois
2022

L. PUBLICATIONS

L.1. Thesis

- [1] D. Schonfeld, *Optimal Morphological Representation and Restoration of Binary Images: Theory and Applications*. Department of Electrical and Computer Engineering, The Johns Hopkins University, Baltimore, Maryland, 1990.

L.2. Books

- [1] C.-W. Chen, D. Schonfeld, and J. Liu, (Eds.), *Proceedings of the SPIE/IS&T International Conference on Visual Communications and Image Processing*. SPIE Press, 2007.
- [2] D. Schonfeld, C. Shan, D. Tao, and L. Wang, (Eds.), *Video Search and Mining*. Studies in Computational Intelligence Series, Springer-Verlag, 2010.

L.3. Book Chapters

- [1] M. Charif-Chefchaoui and D. Schonfeld, "Spatially-Variant Mathematical Morphology: Minimal Basis Representation," *Mathematical Morphology and Its Applications to Image and Signal Processing*. P. Maragos, R.W. Schafer, and M.K. Butt, (ed.), pp. 49-56, Kluwer Academic Publishers: Boston, Massachusetts, 1996.
- [2] D. Schonfeld, "Weighted Composite Order-Statistics Filters: Optimal Morphological Pattern Recognition," *Mathematical Morphology and Its Applications to Image and Signal Processing*. P. Maragos, R.W. Schafer, and M.K. Butt, (ed.), pp. 163-170, Kluwer Academic Publishers: Boston, Massachusetts, 1996.
- [3] D. Schonfeld, "Image and Video Communication Networks," (**Invited Chapter**). *Handbook of Image and Video Processing*. A. Bovik (ed.), Academic Press: San Diego, California, Chapter 9.3, pp. 717-732, 2000.

- [4] D. Lelescu and D. Schonfeld, "Video skimming and summarization based on principal component analysis," *Management of Multimedia on the Internet*, Lecture Notes in Computer Science, E.S. Al-Shaer and G. Pacifici (Eds.), Springer-Verlag, pp. 128-141, 2001.
- [5] F. Bashir, S. Khanvilkar, A. Khokhar, and D. Schonfeld, "Multimedia systems: Content based indexing and retrieval," (**Invited Chapter**). *Electrical Engineering Handbook*. W-K. Chen (ed.), Academic Press: San Diego, California, pp. 379-400, 2004.
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- [8] D. Schonfeld, "Video Communication Networks," (**Invited Chapter**). *The Essential Guide to Video Processing*. A. Bovik (ed.), Elsevier: Chennai, India, Chapter 16, pp. 473-526, 2009.
- [9] X. Ma, X. Chen, A. Khokhar, and D. Schonfeld, "Motion trajectory-based video retrieval, classification, and summarization," *Video Search and Mining*. Studies in Computational Intelligence Series, Springer-Verlag, pp. 53-82, 2010.
- [10] J. J. GadElkarim, D. Schonfeld, O. Ajilore, L. Zhan, A. Zhang, J.D. Feusner, P. M. Thompson, T. J. Simon, A. Kumar, and A. D. Leow, "A framework for quantifying node-level community structure group differences in brain connectivity networks," *Medical Image Computing and Computer-Assisted Intervention – MICCAI, Lecture Notes in Computer Science*. Vol. 7511, pp. 196-203, 2012.
- [11] N. Bouaynaya, R. Shterenberg, D. Schonfeld, and H. M. Fathallah-Shaykh, "Intervention and Control of Gene Regulatory Networks: Theoretical Framework and Application to Human Melanoma Gene Regulation," F. Emmert-Streib, and M. Dehmer, Matthias (eds.), *Statistical Diagnostics for Cancer: Analyzing High-Dimensional Data*. Wiley-VCH, Quantitative and Network Biology, 2013.
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L.4. Journal Editorials

- [1] D. Schonfeld, J. Goutsias, I. Shmulevich, I. Tabus, and A.H. Tewfik, "Introduction to the issue on genomic and proteomic signal processing," *IEEE Journal of Selected Topics in Signal Processing*, Special Issue on Genomic and Proteomic Signal Processing, vol. 2, pp. 257-260, 2008.

- [2] S.-F. Chang, J. Luo, S. Maybank, D. Schonfeld, and D. Xu, "An Introduction to the special issue on event analysis in videos," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 18, pp. 1469-1472, 2008.
- [3] D. Schonfeld, "Perspectives on special issues," *IEEE Signal Processing Magazine*, vol. 26, issue 5, 2009.
- [4] D. Schonfeld, "The evolution of signal processing," *IEEE Signal Processing Magazine*, vol. 27, issue 5, 2010.
- [5] R. Chellappa, W. Heinzelman, J. Konrad, D. Schonfeld, and M. Wolf, "Introduction to Special Section on Distributed Camera Networks: Sensing, Processing, Communication, and Implementation," Special Section on Distributed Camera Networks: Sensing, Processing, Communication, and Implementation, *IEEE Transactions on Image Processing*, vol. 19, pp. 2513-2515, 2010.
- [6] D. Schonfeld, J. Biemond, G. de Haan, and A. Kaup, "Introduction to the issue on recent advances in video processing for consumer displays," *IEEE Journal of Selected Topics in Signal Processing*, Special Issue on Recent Advances in Video Processing for Consumer Displays, vol. 5, pp. 213-216, 2011.
- [7] L. Di Stefano, C. Regazzoni, and D. Schonfeld, "Advanced Video-Based Surveillance," *EURASIP Journal on Image and Video Processing*, Special Issue on Advanced Video-Based Surveillance, Volume 2011, Article ID 857084, 2 pages, 2011.
- [8] D. Schonfeld and D. Li, "Signal Processing Trends in Media, Mobility, and Search," *IEEE Signal Processing Magazine*, vol. 28, issue 4, 2011.
- [9] L. Najman, J. Barrera, B. S. D. Sagar, P. Maragos, and D. Schonfeld, "Introduction to the issue on filtering and segmentation with mathematical morphology," *IEEE Journal of Selected Topics in Signal Processing*, vol. 6, pp. 737-738, 2012.
- [10] D. Schonfeld, "Editor-in-chief message," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 24, pp. 181-182, 2014.
- [11] D. Schonfeld, "Editor-in-chief message," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 25, p. 181, 2015.

L.5. Refereed Journal Papers

- [1] D. Schonfeld and J. Goutsias, "Optimal morphological pattern restoration from noisy binary images," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 13, pp. 14-29, 1991.
- [2] D. Schonfeld and J. Goutsias, "On the morphological representation of binary images in a noisy environment," *Journal of Visual Communication and Image Representation*, vol. 2, pp. 17-30, 1991.
- [3] J. Goutsias and D. Schonfeld, "Morphological representation of discrete and binary images," *IEEE Transactions on Signal Processing*, vol. 39, pp. 1369-1379, 1991.

- [4] D. Schonfeld, "On the hysteresis and robustness of Hopfield neural networks," *IEEE Transactions on Circuits and Systems---II: Analog and Digital Signal Processing*, vol. 40, pp. 745-748, 1993.
- [5] D. Schonfeld, "Optimal structuring elements for the morphological pattern restoration of binary images," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 16, pp. 589-601, 1994.
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- [9] M. Charif-Chefchaoui and D. Schonfeld, "Morphological representation of order-statistics filters," *IEEE Transactions on Image Processing*, vol. 4, pp. 838-845, 1995.
- [10] M. Charif-Chefchaoui and D. Schonfeld, "On the convergence and roots of order-statistics filters," *IEEE Transactions on Signal Processing*, vol. 43, pp. 1990-1993, 1995.
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- [15] D. Schonfeld and D. Lelescu, "VORTEX: Video retrieval and tracking from compressed multimedia databases—multiple object tracking from MPEG-2 bitstream," **(Invited Paper)**. *Journal of Visual Communication and Image Representation*, Special Issue on Multimedia Database Management, vol. 11, pp. 154-182, 2000.
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- [22] D. Schonfeld and G. Friedman, "On the optimality of hysteresis in signal processing and communication systems," *The Journal of the Franklin Institute*, vol. 342, pp. 749-759, 2005.
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L.8. Patents

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M. PANEL SPEAKER

Working With Expert Witnesses

Quinn Emanuel Intellectual Property Academy

Chicago, Illinois

2024

N. KEYNOTE AND PLENARY TALKS

Stochastic noise process enhancement of nonlinear filtering

INPT/ASME International Conference on Communications, Signals and Systems

Rabat, Morocco

1995

VORTEX: Video Retrieval and Tracking from Compressed Multimedia Databases

INPT/ASME International Conference on Communications, Signals and Systems

Rabat, Morocco

2001

MotionSearch: Content-Based Video Retrieval and Activity Recognition in Video Surveillance

IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS)

Genoa, Italy

2009

Distributed Multi-Camera Networks: Graphical Models, Tensor Representation, and Plenoptic Functions

IEEE International Conference on Networking, Sensing, and Control (ICNSC)

Chicago, Illinois

2010

Signal Processing for Distributed Multi-Camera Networks: Theory and Applications

IEEE/IET International Conference on Audio, Language and Image Processing (ICALIP)

Shanghai, China

2010

The Visual Brain: Biologically-Inspired Imaging and Vision

International Conference on Intelligent Control and Information Processing (ICICIP)

International Conference on Brain Inspired Cognitive Systems (BICS)

Beijing, China

2013

Distributed Multi-Camera Networks: Graphs, Grammars, and Tensors

International Conference on Wireless Communications and Signal Processing (WCSP)

Yangzhou, China

2016

University of Illinois – New Oriental Artificial Intelligence Research Laboratory

N-Brain Alliance Launch & Product Release Conference

New Oriental AI Research Academy

Beijing, China

2018

AI Technology in Education and Academic Thinking

Think for Education Conference (TEC) AI+Education

Beijing, China

2018

Adversarial Networks: Deep Learning, Steganography, and Forgery Detection

IEEE International Conference on Computer, Electrical and Communication Engineering (ICCECE)

Kolkata, India

2023

O. INVITED SEMINARS

Optimal morphological representation and detection of binary images

Department of Electrical Engineering and Computer Science

Northeastern University

Boston, Massachusetts

1990

Optimal morphological representation and detection of binary images

The Johns Hopkins University

Applied Physics Laboratory

Laural, Maryland

1990

Optimal morphological representation and detection of binary images

Center for Automation Research

University of Maryland

College Park, Maryland

1990

Optimal morphological representation and restoration of binary images: Theory and applications

Department of Electrical and Computer Engineering

Illinois Institute of Technology

Chicago, Illinois

1990

Optimal morphological representation and restoration of binary images: Theory and applications

Department of Electrical and Computer Engineering

University of California

Santa Barbara, California

1990

Optimal morphological representation and restoration of binary images: Theory and applications

Department of Electrical Engineering and Computer Science

Northwestern University
Evanston, Illinois
1991

Morphological image processing and analysis: Theory and applications

Department of Electrical and Computer Engineering
University of Illinois
Urbana-Champaign, Illinois
1992

Morphological image representation: Theory and applications

DOD Tri-Service Workshop on Stochastic Methods in Image Analysis
U.S. Army Harry Diamond Laboratories
Adelphi, Maryland
1992

Morphological representation of nonlinear filters: Theory and applications

Department of Electrical and Computer Engineering
Illinois Institute of Technology
Chicago, Illinois
1993

Morphological image representation: Theory and applications

ONR Workshop on Vision and Optical Information Processing
Arlington, Virginia
1994

Nonlinear Signal and Image Processing

Department of Electrical Engineering and Computer Science
University of Illinois
Chicago, Illinois
1996

Nonlinear Operators: Theory and Application to Image Processing and Communications

School of Electrical and Computer Engineering
Technion – Israel Institute of Technology
Haifa, Israel
1996

Stochastic Noise Process Enhancement of Nonlinear Filtering

Department of Electrical Engineering
Northern Illinois University
DeKalb, Illinois
1996

Morphological Signal and Image Processing: Theory and Applications

Department of Electrical Engineering—Systems
University of Tel-Aviv
Tel-Aviv, Israel
1997

VORTEX: Video Retrieval and Tracking from Compressed Multimedia Databases

Department of Electrical and Computer Engineering

Illinois Institute of Technology

Chicago, Illinois

2001

Mathematical Morphology and Computer Vision

University of Illinois Chicago

Chicago, Illinois

2002

VORTEX: Video Retrieval and Tracking from Compressed Multimedia Databases

Department of Electrical and Computer Engineering

Drexel University

Philadelphia, Pennsylvania

2002

**Time-Series Analysis Based on Statistical Signal Processing:
Segmentation, Prediction, and Tracking**

Global Electronic Trading Company (Getco)

Chicago, Illinois

2004

Particle Filtering for Head Tracking in Wireless Communications

Motorola Research Labs

Schaumburg, Illinois

2004

Real-Time Video Communications: Compression, Tracking, Retrieval, and Networking

University of Illinois

Chicago, Illinois

2005

Real-Time Video Tracking and Retrieval from Multimedia Databases

Motorola Research Labs

Schaumburg, Illinois

2005

**Real-Time Multiple Object Tracking and Motion Trajectory-Based Video Databases:
Indexing, Retrieval, and Activity Recognition**

Hewlett-Packard Research Labs

Haifa, Israel

2005

Real-Time Video Tracking Based on Particle Filtering

University of Illinois

Chicago, Illinois

2005

**Real-Time Collaborative Distributed Tracking and Trajectory Analysis from Multiple
Camera and Sensor Networks**

School of Electrical and Computer Engineering
Purdue University
West Lafayette, Indiana
2005

A New Method for Multidimensional Optimization and Its Application in Image and Video Processing

Department of Electrical Engineering and Computer Science
Northwestern University
Evanston, Illinois
2006

Protein Communication System: Evolution and Genomic Structure

Department of Electrical and Computer Engineering
University of Illinois at Urbana-Champaign
Urbana-Champaign, Illinois
2006

Protein Communication System: Evolution and Genomic Structure

Bioinformatics Group
Mathematics and Computer Science Division
Argonne National Laboratory
Argonne, Illinois
2006

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**

College of Information Science and Engineering
Graduate School
Chinese Academy of Science
Beijing, P.R. China
2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**

Visual Computing Group
Microsoft Research Asia
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2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**

School of Electronic and Information Institute
Tongji University
Shanghai, P.R. China
2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**

School of Automation
Institute of Automation

Hangzhou Dianzi University
Hangzhou, P.R. China
2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**
Department of Information Science and Electronic Engineering
Institute of Information and Communication Systems
Zhejiang University
Hangzhou, P.R. China
2007

InteractiveVision: Distributed Image and Video Processing
Intellectual Property Technical Lecture Series
McAndrews, Held & Malloy, Ltd.
Chicago, Illinois
2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**
Departments of Computer Science and Electrical & Computer Engineering
Technion, Israel Institute of Technology
Haifa, Israel
2007

MotionSearch: Content-Based Video Retrieval and Classification
Joint Chapters of the IEEE
Rochester, New York
2008

Evolution and Genomic Structure: A Signal Processing Perspective
Bioinformatics Cluster
University of Rochester
Rochester, New York
2008

Evolution and Genomic Structure: A Signal Processing Perspective
Department of Electrical Engineering
Columbia University
New York, New York
2008

Evolution and Genomic Structure: A Signal Processing Perspective
Department of Electrical Engineering and Computer Science
Northwestern University
Evanston, Illinois
2008

MotionSearch: Content-Based Video Retrieval and Classification
Distinguished Speaker in the Joint College Colloquium Series
College of Engineering and Information Technology and College of Science and Mathematics

Department of Applied Science
University of Arkansas at Little Rock
Little Rock, Arkansas
2008

Evolution and Genomic Structure: A Signal Processing Perspective

Department of Electrical and Computer Engineering
University of Wisconsin – Madison
Madison, Wisconsin
2008

MotionSearch: Content-Based Video Retrieval and Classification

Department of Electrical & Computer Engineering
Tufts University
Medford, Massachusetts
2009

MotionSearch: Content-Based Video Retrieval and Classification

Department of Electrical & Microelectronics Engineering
Rochester Institute of Technology
Rochester, New York
2009

MotionSearch: Content-Based Video Retrieval and Classification

School of Computer Engineering
Nanyang Technological University
Singapore
2009

**Distributed Multi-Camera Networks: Graphical Models, Tensor Representation,
and Plenoptic Functions**

Department of Electrical and Computer Engineering
Illinois Institute of Technology
Chicago, Illinois
2010

**Personalized Visual Interaction: Robust Video-Conferencing and
Human-Computer Interaction Using a Two-Camera Computer System**

Qualcomm Corp.
San Diego, California
2010

Evolution and Genomic Structure: A Signal Processing Perspective

Department of Information Engineering and Computer Science - DISI
Microsoft Research-University of Trento Centre for Computational and Systems Biology
University of Trento
Trento, Italy
2010

**A Novel Cache Optimization Algorithm and Video Streaming Protocol
for Pure Peer-to-Peer Networks**

Motorola Research Labs
Schaumburg, Illinois
2010

Distributed Multi-Camera Networks: Graphical Models, Tensor Representation, and Plenoptic Functions

Research Center of Automation
Northeastern University
Shenyang, P.R. China
2010

Distributed Multi-Camera Networks: Graphical Models, Tensor Representation, and Plenoptic Functions

School of Automation and Electric Engineering
Zhejiang University of Science and Technology
Hangzhou, P.R. China
2010

Distributed Multi-Camera Networks: Graphical Models, Tensor Representation, and Plenoptic Functions

Center for OPTical IMagery Analysis and Learning (OPTIMAL)
State Key Laboratory of Transient Optics and Photonics
Xi'an Institute of Optics and Precision Mechanics
Chinese Academy of Sciences
Xi'an, P.R. China
2010

Distributed Multi-Camera Networks: Graphs, Grammars, and Tensors

Dean's Leadership in Innovation Seminar Series
Advanced Analytics Institute (AAI)
University of Technology
Sydney, Australia
2012

Genomic Signal Processing: Evolution, Structure, and Regulation

Dean's Leadership in Innovation Seminar Series
Advanced Analytics Institute (AAI)
University of Technology
Sydney, Australia
2012

Distributed Multi-Camera Networks: Theory and Applications

Harbin Engineering University (HEU)
Harbin, China
2014

Distributed Multi-Camera Networks: Theory and Applications

Electrical and Computer Engineering Graduate Program
Ryerson University
Toronto, Canada
2014

Genomic Signal Processing: Evolution, Structure, and Regulation

Distinguished Lecturer Seminar Series
Electrical Engineering Department
The Pennsylvania State University
University Park, Pennsylvania
2015

Genomic Signal Processing: Evolution, Structure, and Regulation

School of Electrical & Electronic Engineering
Nanyang Technological University
Singapore
2015

P. GRADUATE STUDENTS AND VISTING SCHOLARS

P.1. Visiting Scholars

Mohammed Charif-Chefchaoui

Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1995

Position: Director and Professor, National Institute of Postes and Telecommunications, Morocco.

Yuesong Lin

Department of Electrical and Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2007

Position: Professor, Institute of Information and Control, Hangzhou Dianzi University, Hangzhou, P.R. China.

Haihong Chi

Department of Electrical and Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2010

Position: Associate Professor, College of Automation, Harbin Engineering University (HEU), Harbin, P.R. China.

Claudio Piciarelli

Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
2010

Position: Postdoctoral Fellow, Department of Mathematics and Computer Science, University of Udine, Udine, Italy.

P.2. Postdoctoral Fellows

Mohammed Charif-Chefchaoui

Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1994

Position: Director and Professor, National Institute of Postes and Telecommunications, Morocco.

P.3. Visiting Students

Alessio Dore

Department of Electrical and Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2008

Former Position: Doctoral Candidate, DIBE - Department of Biophysical and Electronic Engineering, University of Genova, Genoa, Italy.

Current Position: Postdoctoral Fellow, Imaging Sciences Centre, Institute of Biomedical Engineering, Imperial College, London, United Kingdom.

Yunmei Gong

Department of Electrical and Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2008-09

Current Position: Doctoral Candidate, Information and Communication Engineering, College of Electronics and Information Engineering, Tongji University, Shanghai, P.R. China.

Nicola Piatto

Department of Electrical and Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2010

Current Position: Doctoral Candidate, Department of Engineering and Computer Science – DISI, Multimedia Signal Processing and Understanding Lab – MMLab, University of Trento, Trento, Italy.

P.4. Doctoral Students

Mohammed Charif-Chefchaoui

“Morphological Representation of Nonlinear Filters: Theory and Applications”

Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1993

Former Position: Professor, National Institute of Postes and Telecommunications, Rabat, Morocco.

Current Position: Director, National Institute of Postes and Telecommunications, Rabat, Morocco.

Dan Lelescu

“VORTEX: Video Retrieval and Tracking from Compressed Multimedia Databases”

Department of Electrical Engineering and Computer Science

University of Illinois Chicago

Chicago, Illinois

2000

Former Position(s): Senior Research Scientist, Lead of Algorithms Group, Compression Sciences, Campbell, California, USA; Senior Researcher, NTT DoCoMo Communications Laboratories USA, San Jose, California, USA; Principal Scientist, Advanced Imaging Research & Development Laboratory, Micron Technology, California, USA; Chief Scientist, Pelican Imaging Corporation, Mountain View, California, USA; Chief Scientist, Emergent VR, Campbell, California, USA.

Current Position: Engineer, Apple, Cupertino, California, USA.

Bulent Cavusoglu

“Real-Time Content-Based Video Communications over Heterogeneous Networks”

(Jointly Supervised with Prof. Rashid Ansari)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2005

Current Position: Professor, Ataturk University, Erzurum, Turkey.

Faisal Bashir

“MotionSearch: Object Motion Trajectory-Based Video Search and Classification System”

(Jointly Supervised with Prof. Ashfaq Khokhar)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2006

Internship: Mitsubishi Electric Research Laboratory (MERL), USA.

Former Position(s): Intern, Mitsubishi Electric Research Laboratory (MERL), Cambridge, Massachusetts, USA; Senior Imaging Scientist, Retica Systems, Inc., Waltham, Massachusetts, USA; Senior Vision Engineer, Heartland Robotics, Cambridge, Massachusetts, USA.

Current Position: Senior Principal Engineer – Advanced Development Group, Security and Detection Systems, L-3 Communications, Woburn, Massachusetts, USA.

Wei Qu

“Real-Time Distributed Video Tracking of Multiple Objects from Single and Multiple Cameras”

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2006

Internship: Mitsubishi Electric Research Laboratory (MERL), USA; Siemens Medical Systems, USA.

Former Position(s): Senior Research Scientist, Motorola Research Labs, Schaumburg, Illinois, USA; Senior Scientist, Siemens Medical Solutions USA, Hoffman Estates, Illinois, USA; Associate Professor, Graduate University of Chinese Academy of Sciences, Beijing, China; CEO Special Assistant, Director of Technology, President of CSST Research, Hong Kong; Vice President, R&D, Special Assistant to CEO, President of Beijing Research Institute, Beijing, China; Co-Founder, SmartVision Technology, Beijing, China.

Current Position: President, Artificial Intelligence Research Institute, New Oriental Education & Technology Group Inc., Beijing, China.

Nidhal Bouaynaya

“Analysis of Proteomics and Genomics Based on Signal Processing and Communication Theory”

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2007

Former Position: Assistant Professor, Department of Systems Engineering, University of Arkansas at Little Rock, Little Rock, Arkansas, USA.

Current Position: Associate Dean for Research & Graduate Studies, Rowan University, Glassboro, New Jersey, USA.

Hunsop Hong

Constrained and Hierarchical Density Estimation for Image Reconstruction and Sensor Networks

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2008

Current Position: Senior Research Engineer, Samsung Information Systems America, Irvine, California, USA.

Pan Pan

Video Tracking Based on Particle Filters: Particle Allocation, Graphical Models, and Performance Evaluation

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2009

Internship: NTT Research Laboratory, Japan; Mitsubishi Electric Research Laboratory (MERL), USA.

Former Position: Senior Researcher, Project Manager, Fujitsu Research and Development, Beijing, China.

Current Position: Technical Director, Alibaba Group, Beijing, China.

Xiang Ma

Motion Trajectory-Based Video Retrieval and Recognition: Tensor Analysis and Multi-Dimensional Hidden Markov Models

(Jointly Supervised with Prof. Ashfaq Khokhar)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2009

Internship: Knowledge Media Institute, Open University, United Kingdom; Siemens Medical Solutions USA, Hoffman Estates, Illinois, USA; Computer Vision Research Engineer, IntuVision, Inc., Woburn, Massachusetts, USA.

Former Position: Senior Research Scientist and Engineer, IntuVision, Inc., Woburn, Massachusetts, USA; Lead Engineer – 3D Maps & Reality Capture Processing, Nokia, Chicago, Illinois, USA;

Research Manager, Manager of Engineering – Computer Vision, Artificial Intelligence R&D, HERE Technologies, Chicago, Illinois, USA; Applied Science Manager – Computer Vision and Artificial Intelligence, Amazon, Boston, Massachusetts, USA.

Current Position: Head of Research – Amazon Dash Carts, Senior Manager of Applied Sciences, Amazon, Boston, Massachusetts, USA.

Junlan Yang

Virtual Video Enhancement for Handheld Mobile Cameras: Stabilization, Auto-Focus, and Super-Resolution

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2009

Internship: Ricoh Research Laboratory, Menlo Park, California, USA; Sharp Laboratories of America, USA.

Former Position: Senior Software Engineer, iKoa Corporation, Menlo Park, California, USA; Research Scientist, Marseille Networks, Santa Clara, California, USA.

Current Position: Senior Software Engineer, Google LLC, Mountain View, California, USA.

Chong Chen

Multi-Camera Vision Systems: Distributed Pose Estimation and Plenoptic Imaging

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2009

Internship: Siemens Research Laboratory, USA; FX Palo Alto Laboratory (FXPAL), USA; Abbott Laboratories, USA.

Former Position: Senior Research Engineer, Samsung Information Systems America, Irvine, California, USA.

Current Position: Video Engineer, Apple, Cupertino, California, USA.

Xu Chen

Localization and Trajectory Estimation of Mobile Objects from a Single Sensor

(Jointly Supervised with Prof. Ashfaq Khokhar)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2010

Internship: Institute of Electrical Engineering, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland; Kodak Research Laboratories, USA.

Former Position(s): Postdoctoral Fellow, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, Michigan, USA; Postdoctoral Fellow, Department of Electrical and Computer Engineering, Duke University, Durham, North Carolina, USA; Senior Researcher, Sharp Laboratories of America, Camas, Washington, USA.

Current Position: Senior Machine Learning Developer, SAS, Cary, North Carolina, USA.

Lei Gao

Compiler Optimization for Translating Software Binaries onto FPGAs

(Jointly Supervised with Prof. Prith Banerjee)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2010

Internship: Binachip, Inc., Chicago, Illinois, USA.

Former Position: Senior Engineer, Binachip, Inc., Chicago, Illinois, USA.

Current Position: Staff R&D Engineer, Synopsis, Inc., Marlborough, Massachusetts, USA.

Liuling Gong

Machine Learning for Signal Processing:

Geometry, Kernels, and Symbolic Sequences

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2010

Internship: eBay Research Labs, USA.

Former Position: Postdoctoral Fellow, Center for the Study of Complex Systems, University of Michigan, Ann Arbor, Michigan, USA; Seismic Imager, CGGVeritas, Houston, Texas, USA; Data Scientist, GE Oil & Gas, Houston, Texas, USA.

Current Position: Data Scientist, Equinor, Houston, Texas, USA.

Songqing Zhao

Multiple Description Coding for Correlated Multi-Path Networks

(Jointly Supervised by Profs. Rashid Ansari and Daniela Tuninetti)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2010

Internship: Mitsubishi Electric Research Laboratory (MERL), USA.

Former Position: Voice and Data Quality Engineer, Voice & Data Quality and Performance Analysis Group, Alcatel-Lucent, Murray Hill, New Jersey, USA.

Current Position: Senior Wireless Engineer, Apple, Cupertino, California, USA.

Xiangqiong Shi

Bayesian Networks: Performance Analysis of Loopy Belief Propagation

(Jointly Supervised with Prof. Daniela Tuninetti)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2011

Internship: Motorola Research Labs, Schaumburg, Illinois, USA; Technicolor, Research & Innovation, Princeton, New Jersey, USA; Nokia Research Center, Palo Alto, California, USA.

Former Positions: Software Engineer, Volkswagen of America, Electronics Research Lab, Herndon, Virginia, USA; Software Engineer, Apple, Cupertino, California, USA.

Current Position: Software Engineer, Ouster, San Francisco, California, USA.

Liming Wang

Genomic Signal Processing and Regulatory Networks: Representation, Dynamics and Control

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2011

Former Position: Postdoctoral Fellow, Department of Electrical Engineering, Columbia University, New York, New York, USA; Postdoctoral Associate, Department of Electrical and Computer Engineering, Duke University, Durham, North Carolina, USA; Postdoctoral Associate, Department of Electrical and Computer Engineering, Ohio State University, Columbus, Ohio, USA.

Current Position: Lead Data Scientist, HERE Technologies, Chicago, Illinois, USA.

Jing Huang

Distributed Signal and Image Processing:

Particle Filters, Context Grammars, and Dynamic Games

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2013

Internship: Fuji Xerox Palo Alto Laboratory (FXPAL), Palo Alto, California, USA; Motorola Mobility, Applied Research Center, Libertyville, Illinois, USA; Nokia Research Center, Berkeley, California, USA.

Former Positions: Software Development Engineer, TeraRecon, Inc., Foster City, California, USA; Senior Deep Learning Software Engineer, Intel Artificial Intelligence, Intel Corporation, Santa Clara, California.

Current Position: Software Engineer, Microsoft Artificial Intelligence & Research, Bellevue, Washington, USA.

Qun Li

Multilinear Algebra in High-Order Data Analysis: Retrieval, Classification and Representation

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2013

Internship: Xerox Research Center, Xerox Innovations Group, Webster, New York, USA.

Former Positions: Research Scientist, Xerox Research Center, Xerox Innovations Group, Webster, New York, USA; Research Scientist, PARC, A Xerox Company, Palo Alto, California, USA.

Current Position: Senior Data Scientist, Microsoft, Bellevue, Washington, USA;

Johnson Jonaris GadElkarim Keiriz

From Micro to Macro: A Study of Human Brain Structure Based on Diffusion MRI and Neuronal Networks

(Jointly Supervised by Profs. Alex Leow and Richard Magin)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2013

Former Position: Postdoctoral Fellow, Department of Psychiatry, University of Illinois Chicago, Illinois, USA; Lead Developer, nView medical Inc., Salt Lake City, Utah, USA; Research Scientist, Tamaggo, Montreal, Quebec, Canada; Research Scientist – Senior Software Engineer, Object Research Systems (ORS) Inc., Montreal, Quebec, Canada; Research Associate, Electronic Visualization Laboratory (EVL), University of Illinois Chicago (UIC), Chicago, Illinois; USA.

Current Position: Principal CT Software Engineer, Canon Medical Research USA, Inc. Vernon Hills, Illinois, USA.

Lingdao Sha

When Sparsity Meets Graphs, Images, Structured and High-Dimensional Data

(Jointly Supervised with Prof. Jing Wang)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2018

Former Position: Senior Machine Learning Scientist, Tempus Labs, Inc., Chicago, Illinois, USA.

Current Position: Applied Scientist II, Amazon, San Diego, California.

Haoyu Wang

Depth-constrained Feature-based Stitching System for Stereoscopic Panoramic Video Generation

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2019

Current Position: Computer Vision Engineer, Blackmagic Design, Colorado Springs, Colorado, USA.

Mehdi Sharifzadeh

Steganography and Steganalysis of Raw and Compressed Image Data

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2019

Internships: Software Engineering Intern, Google Brain, Mountain View, California, USA; Data Scientist Intern, Western Digital, Milpitas, California, USA; Data Scientist Intern, SanDisk, Milpitas, California, USA.

Previous Position: Research Engineer, Snap, Inc., Santa Monica, California, USA.

Current Position: Senior Software Engineer, Google, Inc., Los Angeles, California, USA.

Chirag Agarwal

Robustness and Explainability of Deep Neural Networks: Architectures and Applications

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2020

Internships: Research Intern, Geisinger Health Systems, Danville, Pennsylvania, USA; Research and Development Intern, Kitware Inc., Clifton Park, New York, USA; Imaging Science Intern, Tempus Labs Inc., Chicago, Illinois, USA; Computer Vision / Augmented Reality Intern, Robert Bosch LLC, Farmington Hills, Michigan, USA.

Previous Position: Postdoctoral Research Fellow, Department of Computer Science, Department of Biomedical Informatics, and Business School, Harvard University, Cambridge, Massachusetts, USA; Research Scientist, Media and Data Science Research Laboratory, Adobe Research, Bangalore, India.

Current Position: Assistant Professor, Department of Computer Science, School of Engineering, and Program of Data Science, School of Data Science, University of Virginia, Charlottesville, Virginia, USA.

Mohammed Aloraini

Digital Media Forgery Detection

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2020

Current Position: Assistant Professor, Head of Electrical Engineering Department, Vice Dean of Academic Affairs, Qassim University, Buraydah, Qassim, Saudi Arabia.

Igor Fortel

Excitation-Inhibition Balance: A Study of Brain Network Dynamics Using Statistical Mechanics
(Jointly Supervised by Prof. Alex Leow)
Department of Biomedical Engineering
University of Illinois Chicago
Chicago, Illinois
2021

Current Position: Systems Design Engineer, T-Mobile, Chicago, Illinois; Research Specialist, University of Illinois Chicago, Chicago, Illinois.

Deepika Aggarwal

Deep Learning Networks
Department of Electrical and Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2026 (Est.)
Current Position: TBD.

Sayan Koley

Deep Learning Networks
Department of Electrical and Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2026 (Est.)
Current Position: TBD.

P.5. Masters Thesis Students

Vladimir Pavlovic

“Stochastic Noise Process Enhancement of Hopfield Neural Networks”
(Jointly Supervised with Prof. Gary Friedman)
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1993
Position: Professor, Department of Computer Science, Rutgers University, New Jersey, USA.

Deepak K. Bal

“Transmission of Real-Time MPEG-2 Video Over Differentiated Services Networks”
(Jointly Supervised with Prof. Rashid Ansari)
Department of Electrical & Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2003
Position: Takata, Inc., Michigan, USA.

Karthik Hariharakrishnan

“Visual Tracking: New Methods Using Adaptive Block Matching and Particle Filters”
Department of Electrical & Computer Engineering
University of Illinois Chicago

Chicago, Illinois

2003

Internship: NeoMagic Corp., USA.

Previous Position(s): National Instruments, India; Motorola, India; Senior Design Engineer, ARM, Ltd., United Kingdom.

Current Position: Staff Software Engineer, ARM, Ltd., United Kingdom.

Subhash Balam

“Associative Processors for Video Coding”

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2004

Position: Senior Staff Engineer/Manager, Qualcomm Corp., California, USA.

Emir Mulabegovic

“Lightweight Streaming Protocol for Real-Time Video Communications”

(Jointly Supervised with Prof. Rashid Ansari)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2005

Former Position: PCTEL, Illinois, USA.

Current Position: Systems Architect, Personal, Inc., Sarajevo, Bosnia and Herzegovina.

Andrea De Mauro

“A Peer-to-Peer Network for Real-Time Multiple-Description Video Communications Using Multiple Paths”

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2006

Former Position: Financial Solutions Systems Analyst, Procter & Gamble, Newcastle, United Kingdom.

Current Position: Business Intelligence Manager, Procter & Gamble, Newcastle, Rome, Italy.

Claudio Rossi

“A Partially-Reliable Multihomed Transport Protocol for Real-Time Multiple-Description Multimedia Traffic”

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2006

Position: Area Manager, IBM, Milan, Italy.

Amita Talati

Design and Evaluation of Data Compression and Decompression Applications on Field Programmable Gate Arrays

(Jointly Supervised with Prof. Prith Banerjee)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2008

Former Position: Customer Applications Engineer, Newark Corporation, Cleveland, Ohio, USA.

Current Position: Senior Engineer, Newark Corporation, Cleveland, Ohio, USA.

Carlo Giulietti

A Novel Cache Optimization Algorithm and Protocol for Video Streaming in Pure Peer-to-Peer Networks

(Jointly Supervised with Prof. Rashid Ansari)

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2010

Position: Software Engineer, Astek, Sophia Antipolis, France.

Edmond Gjondrekaj

Clustering and Similarity Analyses of miRNA Assay by Means of Reprogrammable Devices

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2010

Alberto Mannari

Enhanced Frame Buffer Management for HEVC Encoders and Decoders

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2015

Position: Specialist Electronics Engineer, Teoresi Inc., Burr Ridge, Illinois; Software Developer, IBM, San Jose, California, and Rüschlikon, Zurich, Switzerland.

Vasundhara Goyal

Generation of Stereoscopic Video From Monocular Image Sequences Based on Epipolar Geometry

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2017

Position: Embedded Software Developer, Pi Square Technologies, Farmington, Michigan; Senior Embedded Software Developer, Lead and Scrum Master, ASML, Wilton, Connecticut; ADAS Feature & Software Developer, Ford Motor Company, Dearborn, Michigan.

Akreem Talal Mohammed Saeed

Location Based Assistant on Android Platform

Department of Electrical & Computer Engineering

University of Illinois Chicago

Chicago, Illinois

2017

Position: Lecturer and Director of Information Technology Services, Ninevah University, Mosul, Iraq.

Lorenzo Norcini

Attention-Guided Mask Propagation for Video Object Segmentation

Department of Computer Science

University of Illinois Chicago
Chicago, Illinois
2019

Position: Senior Software Development Engineer, Amazon Web Services, Seattle, Washington.

Francesca Pistilli

GraphPointNet: Graph Convolutional Neural Network for Point Cloud Denoising
Department of Electrical & Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2019

Position: Doctoral Student, Politecnico di Torino, Turin, Italy; Assistant Professor, Politecnico di Torino, Turin, Italy.

Francesco Donato

CoTraM: Convolutional Transformer for Multichannel Time-Series Classification
(Jointly Supervised with Prof. Bharati Prasad)
Department of Electrical & Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2023

Position: Machine Learning Research Engineer, Istituto Italiano di Tecnologia, Genoa, Italy; Machine Learning Research Engineer, Sony Interactive Entertainment, San Mateo, California.

Matteo Carnevale Schianca

Deep Joint Denoising and Compression for Satellite Images
(Jointly Supervised with Prof. Enrico Magli)
Department of Electrical & Computer Engineering
University of Illinois Chicago
Chicago, Illinois
2025
Position: TBD.

P.6. Masters Project Students

Neil Zalut

“Linear Restoration of Medical Images: An Overview”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1993

Branislav Kisacanin

“A Fast Thresholded Linear Convolution Representation of Morphological Operations”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1993

Alan Baumgartner

“Morphological Segmentation of Computed Tomography Images”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1994

Alvin Ng

“Spatially-Variant Morphological Skeleton Representation”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1994

Smriti Anand

“Efficient Fast Reconstruction Algorithms in Computerized Tomography”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois, May 1995

Stephan W. Wegerich

“Subband Image Restoration and Blur Identification Using the EM Algorithm and Cross-Filtering”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1995

Robert Werckmeister

“Performance Analysis of Video Communications in Multimedia Networks”
(Jointly Supervised with Prof. Ouri Wolfson)
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1996

Margaret Kelton

“A Fast Method for Transform Conversion for Use in Image Processing”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1998

Kailash Ravishankar

“Frequency Prediction of High-Order Autoregressive Moving Average Sequences”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1998

Amir Yafe

“Transmission of MPEG-2 Streams Over Packet-Switched Networks”

Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1998

Steven J. Doering

“Digital Modulation: Applications to CDMA Communication Systems (IS-95)”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1999

Abhijit Bhattacharya

“MPEG-1 and H.263 Video Decoding on Motorola GSM Cellular Phone”
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
1999

Qin Cai

“Differentiated Transmission of MPEG-2 Video Bitstream Over Communication Networks”
(Jointly Supervised with Prof. Rashid Ansari)
Department of Electrical Engineering and Computer Science
University of Illinois Chicago
Chicago, Illinois
2000

Q. RESEARCH GRANTS

D. Schonfeld (PI)

“Morphological image representation: Theory and applications”
Office of Naval Research (ONR)
\$150,000
1991-1995

S. Corson (PI) and D. Schonfeld (Co-PI)

“Parallel processing research”
University of Illinois
Campus Research Board (CRB)
\$14,995
1994-1995

R. Ansari (PI), P. Hesketh (Co-PI), and D. Schonfeld (Co-PI)

“One-step process for instant ticket validation”
GTECH Corporation
\$5,000
1997

D. Schonfeld (PI)

“National Communications Forum”
International Engineering Consortium (IEC)
\$500
2000

D. Schonfeld (PI)
“Real-Time Very-Low Bit-Rate MPEG-4 Video Compression for Wireless Communication Application”
Neomagic Corporation
\$69,553
2001-2003

A. Khokhar (PI), R. Ansari (Co-PI), R. Grossman (Co-PI), D. Schonfeld (Co-PI), and C. Yu (Co-PI)
“High-Speed Terabyte Storage Server Based on Intelligent Disk Technology”
Army Research Office (ARO)
DURIP Program
\$422,626
2002-2004

D. Schonfeld (PI)
“Computer Architectures for Real-Time Video Communications”
Neomagic Corporation
\$76,075
2002-2004

M. Dutta (PI) et al.
“Design of a Super-Biological Eye Sensor System”
Defense Advanced Research Projects Agency (DARPA)
Army Research Office (ARO)
\$200,000 (Seed Project)
2002-2003

D. Schonfeld (PI)
“OMAP Code Composure Studio Software for Real-Time Video Communications”
Texas Instruments, Inc.
DSP University Program
\$4,500
2003

D. Schonfeld (PI)
“Real-Time Object Tracking of Video Sequences on Associative Processor Arrays”
Neomagic Corporation
\$68,750
2003-2005

D. Schonfeld (PI)
“Real-Time Low-Power High-Quality Interactive Video Telephony for Wireless Communication Applications”
Motorola, Inc.
\$19,331
2004-2005

D. Schonfeld (PI)

“Real-Time Low-Power High-Quality Interactive Video Communications for Video Animation and Stereography”

Motorola, Inc.

\$22,000

2005-2006

D. Schonfeld (PI)

“Real-Time High-Quality Video Communications from Handheld Cameras Using Video Stabilization and Auto-Focus”

Motorola, Inc.

\$75,000

2005-2008

D. Schonfeld (PI)

“Interactive Video Communications Based on Stereographic Imaging From a Single Camera”

Motorola, Inc.

\$22,000

2006-2007

A. Khokhar (PI) and D. Schonfeld (Co-PI)

“MotionSearch: Motion Trajectory-Based Object Activity Retrieval and Recognition from Video and Sensor Databases”

National Science Foundation (NSF)

\$410,000

2006-2009

D. Schonfeld (PI)

“Real-Time Financial Forecasting Based on Statistical Signal Processing: Correlation Analysis and Fast Algorithms”

Gelber Group

\$66,522

2006-2007

D. Schonfeld (PI)

“Signal Communication and Processing in a RFID Sensor Network System”

Your Life Essentials

\$4,000

2006-2008

D. Schonfeld (PI)

“MobilePlenoptics: Panoramic Video Communications in Mobile Devices”

Motorola, Inc.

\$22,000

2007-2008

D. Schonfeld (PI)

“Machine Learning and Event Detection in Biological Systems”

VG Bioinformatics, Inc.

\$40,000
2007-2008

A. Khokhar (PI) and D. Schonfeld (Co-PI)
“International Supplement to MotionSearch: Motion Trajectory-Based Object Activity Retrieval and Recognition from Video and Sensor Databases”
National Science Foundation (NSF)
\$37,468
2007-2008

D. Schonfeld (PI)
“InteractiveVision: Collaborative Multiple-Input-Multiple-Output Inverse Problems with Application in Image and Video Processing”
National Science Foundation (NSF)
\$232,496
2007-2010

A. Khokhar (PI) and D. Schonfeld (Co-PI)
“Research Experiences for Undergraduates (REU) Supplement to MotionSearch: Motion Trajectory-Based Object Activity Retrieval and Recognition from Video and Sensor Databases”
National Science Foundation (NSF)
\$12,000
2008-2009

D. Schonfeld (PI)
“Real-time Superresolution for Enhanced Video Streaming”
iKoa Corporation
\$25,000
2008-2009

D. Schonfeld (PI)
“Tracking Performance Evaluation based on a Reflective Model and Perturbation Analysis”
Mitsubishi Electric Research Laboratories (MERL)
\$1,228
2009

R. Magin (PI), M. Ragozzino (Co-PI), K. Rockne (Co-PI), T. Royston (Co-PI), and D. Schonfeld (Co-PI)
“Acquisition of a High Field Magnetic Resonance Imaging System for Science and Engineering Research”
National Science Foundation (NSF)
\$1,995,000
2009

D. Schonfeld (PI), N. Bouaynaya (Key/Senior Personnel), and H.M. Fathallah-Shaykh (Key/Senior Personnel)
“Minimal-Perturbation Dynamic Control of the Melanoma Gene Regulatory Network” (R01)
National Institutes of Health (NIH)
\$1,200,000
2010-2015

X. Joe Zhou (PI), D. Schonfeld (Co-PI), H. Engelhard (Co-PI), R. Magin (Co-PI), and T. Valyi Nagy (Co-PI)

“Probing Intra-voxel Tissue Heterogeneity Using MRI” (R01)

National Institutes of Health (NIH)

NIH R01EB026716-01

\$2,173,399

2018-2023

D. Schonfeld (PI)*

“University of Illinois - New Oriental Artificial Intelligence Research Laboratory (UINO-AIRL)”

New Oriental Education & Technology Group Inc.

\$1,600,425

2019-2024

* Funding was approved by the research sponsor but declined by the university because of potential conflict with export controls.

B. Prasad (PI), D. Schonfeld (Co-Investigator), S. Basu (Collaborator), M. Maienschein-Cline (Collaborator)

“Machine Learning and Exosome Derived Biomarkers of Obstructive Sleep Apnea Induced Hypertension”

National Institutes of Health (NIH)

NIH 1R56HL157182-01A1

\$676,935

2022-2024

R. ADMINISTRATIVE ACTIVITIES

R.1. Administrative Positions

Director

University-Industry Engineering Research Center (UIERC)

College of Engineering

University of Illinois Chicago

2008—2011

Supervisor

Web Development

Department of Electrical & Computer Engineering

University of Illinois Chicago

2001—2002

Director

Timetable Schedule

Department of Electrical Engineering & Computer Science

University of Illinois Chicago

1999—2000

R.2. University Committees

Co-Chair

University All-Campus Promotion and Tenure Committee

University of Illinois Chicago

2010—2011

Member

Graduate College Executive Committee

University of Illinois Chicago

2020—2022

Member

COVID-19 Relief Fund Application Review Committee

University of Illinois Chicago

2022

Member

Dean Review Committee

University of Illinois Chicago

2017—2018

Member

Graduate Mentor Award Committee

University of Illinois Chicago

2014—2016

Member

Chancellor's Graduate Research Fellowship Program

University of Illinois Chicago

2014—2016

Member

University Vision and Strategy

University of Illinois Chicago

2012—Present

Member

University Ad-Hoc Advisory Committee for the Office of Faculty Affairs

University of Illinois Chicago

2012—2013

Member

University Task Force to Review Non-Tenure Promotion Guidelines

University of Illinois Chicago

2011—2012

Member

University Promotion and Tenure Norms and Criteria Committee

University of Illinois Chicago

2011—2012

Member

University Honorary Degree Nominating Committee

University of Illinois Chicago

2010—2011

Member

University Promotion and Tenure Seminar Panel

Natural Science, Health Science, and Engineering

University of Illinois Chicago

2010—2011

Member

University All-Campus Promotion and Tenure Committee

University of Illinois Chicago

2008—2011

Member

University Campus Research Board Committee

University of Illinois Chicago

2001—2004

Member

University Awards Committee

University of Illinois Chicago

1998—2001

Member

Student Appeals Board

University of Illinois Chicago

2004—2005

R.3. College Committees

Member

College Executive Committee

College of Engineering

University of Illinois Chicago

2009-2012, 2015-2017; 2019-2020; 2022-2023

Member

Dean of the College of Engineering Search Committee

College of Engineering

University of Illinois Chicago

2007-2008

Member

Wexler Chair in Information Technology Search Committee

College of Engineering

University of Illinois Chicago
2006

Member

Advisory Committee for Bioinformatics Program in Bioengineering
University of Illinois Chicago
2000—2010

Chair

Networking Curriculum Subcommittee
College of Engineering
University of Illinois Chicago
2005

Member

Departmental Reorganization and Formation Committee
College of Engineering
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1999—2000

R.4. Departmental Committees

Mentoring Coordinator

Department of Electrical & Computer Engineering
University of Illinois Chicago
2021—Present

Chair

Departmental Faculty Search Committee
Department of Electrical & Computer Engineering
University of Illinois Chicago
2006-2008; 2010-2011; 2016-2017

Chair

Departmental Grievance Committee
Department of Electrical & Computer Engineering
University of Illinois Chicago
2013—2019

Chair

Departmental Research & Colloquium Committee
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1996—1998; 2003—2004

Chair

Departmental Seminar Committee
Department of Electrical & Computer Engineering
University of Illinois Chicago

2008—2010

Chair

Departmental Web Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

2001—2003

Chair

Departmental Web & Computer Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

2020-2021

Member

Department of Mathematics, Statistics, and Computer Science

Personnel Review Committee for Jing Wang

2020—2021

Member

Departmental Advisory Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

1995—1996; 1998—1999; 2000—2002; 2004—2005; 2007—2010; 2015—2016; 2022—Present

Member

Departmental Computer Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

1990—1992; 2001—2004

Member

Departmental Computer & Web Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

2013—2016

Member

Departmental Diversity & Inclusion Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

2020—2021

Member

Departmental Electronics Instructional Laboratory Committee

Department of Electrical Engineering & Computer Science

University of Illinois Chicago

1997—1998

Member

Departmental Faculty Search Committee

Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1994—1995; 1998—2001; 2006—2008; 2010-2011; 2016—2017; 2021—Present

Member

Departmental Graduate Admission and Recruitment

Department of Electrical & Computer Engineering
University of Illinois Chicago
2022—2023

Member

Departmental Graduate Committee

Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1995—2000; 2011—2015

Member

Departmental Grievance Committee

Department of Electrical & Computer Engineering
University of Illinois Chicago
2012—2021

Member

Departmental Promotion & Tenure Committee

Department of Electrical & Computer Engineering
University of Illinois Chicago
1996—Present

Member

Departmental Research & Colloquium Committee

Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1992—1998; 2001—2004

Member

Departmental Scholarship Committee

Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1990—1996

Member

Departmental Scholarship & Awards Committee

Department of Electrical & Computer Engineering
University of Illinois Chicago
2019—2023

Member

Departmental Seminar Committee

Department of Electrical & Computer Engineering
University of Illinois Chicago

2008—2013

Member

Departmental Undergraduate Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

1998 – 2003; 2005 – 2011; 2015—2019; 2023 – Present

Member

Departmental Web Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

2000—2011

Member

Departmental Web & Computer Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

2019-2021

R.5. Curriculum Committees

Chair

Departmental Communications and Networks Curriculum Subcommittee

of the Undergraduate and Graduate Committees

Department of Electrical & Computer Engineering

University of Illinois Chicago

2001—2002; 2004

Chair

Departmental Signal Processing Curriculum Subcommittee

of the Undergraduate and Graduate Committees

Department of Electrical & Computer Engineering

University of Illinois Chicago

2011

Member

Departmental Communications Curriculum Subcommittee

of the Undergraduate and Graduate Committees

Department of Electrical & Computer Engineering

University of Illinois Chicago

2011

Member

Departmental Communications and Networking Curriculum Subcommittee

of the Undergraduate and Graduate Committee

Department of Electrical & Computer Engineering

University of Illinois Chicago

2001—2002; 2004

Member

Departmental Computer Engineering Curriculum Subcommittee

of the Undergraduate and Graduate Committee
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1998—2002

Member

Departmental Electrical Engineering Curriculum Subcommittee

of the Undergraduate and Graduate Committee
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1996—2000

Member

Departmental Imaging Curriculum Subcommittee

of the Undergraduate and Graduate Committees
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1993

Member

Departmental Information and Computer Systems Curriculum Subcommittee

of the Undergraduate and Graduate Committees
Department of Electrical & Computer Engineering
University of Illinois Chicago
2011

Member

Departmental Masters of Engineering Program Subcommittee

of the Graduate Committee
Department of Electrical & Computer Engineering
University of Illinois Chicago
2005

Member

Departmental Multimedia Curriculum Subcommittee

of the Undergraduate and Graduate Committees
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
2005

Member

Departmental Networking Curriculum Subcommittee

of the Undergraduate and Graduate Committees
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1999—2000; 2005

Member

Departmental Signals and Systems Curriculum Subcommittee

of the Graduate Committee
Department of Electrical & Computer Engineering
University of Illinois Chicago
2004

Member

Departmental Signal Processing Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical & Computer Engineering
University of Illinois Chicago
2011

Member

Departmental Signal Processing and Communications Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1991

Member

Departmental Student Cheating Policy Subcommittee
of the Undergraduate Committee
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1999

Member

Departmental Teaching Assistant Assignment Subcommittee
of the Undergraduate Committee
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1996—1997

Member

Departmental Teaching Assistant Award Subcommittee
of the Scholarship Committee
Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1994

R.6. Qualifier Committees

Chair

Departmental Communications Qualifier Committee
Department of Electrical & Computer Engineering
University of Illinois Chicago
2003—2004; 2012

Chair

Departmental Computer Communication Network Qualifier Committee

Department of Electrical & Computer Engineering
University of Illinois Chicago
2002—2003; 2005

Chair

Departmental Signal Processing Qualifier Committee

Department of Electrical & Computer Engineering
University of Illinois Chicago
1991—1995; 2001; 2002; 2008—2014, 2015—Present

Member

Departmental Communications Qualifier Committee

Department of Electrical & Computer Engineering
University of Illinois Chicago
1997—2004; 2009—2014

Member

Departmental Computer Communications Networks Qualifier Committee

Department of Electrical & Computer Engineering
University of Illinois Chicago
2002—2005

Member

Departmental Computer Vision Qualifier Committee

Department of Electrical Engineering & Computer Science
University of Illinois Chicago
1993—2001

Member

Departmental Signal Processing Qualifier Committee

Department of Electrical & Computer Engineering
University of Illinois Chicago
1991—2001; 2004—Present

R.7. Research Laboratories and Centers

Director

University-Industry Engineering Research Center (UIERC)
College of Engineering
University of Illinois Chicago
2008—2011

Co-Director

Multimedia Communications Laboratory (MCL)

Department of Electrical & Computer Engineering
University of Illinois Chicago
1997—Present

Member

Departmental Signal and Image Research Laboratory (SIRL)

S. TEACHING ACTIVITIES

S.1. The Johns Hopkins University

ECE 137
Digital Signals and Systems
Fall 1987

ECE 137
Digital Signals and Systems
Fall 1988

ECE 137
Digital Signals and Systems
Fall 1989

S.2. University of Illinois Chicago

EECS 212
Signal Processing
Fall 1990

EECS 212
Signal Processing
Winter 1991

EECS 416
Advanced Topics in Digital Signal Processing
Spring 1991

EECS 417
Digital Signal Processing
Fall 1991

EECS 554
Estimation Theory
Fall 1991

EECS 311
Communication Engineering
Spring 1992

EECS 554
Estimation Theory

Fall 1992

EECS / BioE 479

Real-Time Data Processing

Spring 1993

EECS / BioE 479

Real-Time Data Processing

Fall 1993

EECS 516

Optimal and Adaptive Digital Filters

Fall 1993

EECS 517

Image Processing

Spring 1994

EECS / BioE 479

Real-Time Data Processing

Fall 1994

EECS 517

Image Processing

Spring 1995

EECS 531

Detection and Estimation Theory

Spring 1995

EECS / BioE 479

Real-Time Data Processing

Fall 1995

EECS 517

Image Processing

Spring 1996

EECS 531

Detection and Estimation Theory

Spring 1996

EECS 530

Statistical Communication Theory

Fall 1996

EECS 517

Image Processing

Spring 1997

EECS / BioE 407

Pattern Recognition
Fall 1997

EECS 530
Statistical Communication Theory
Fall 1997

EECS / BioE 407
Pattern Recognition
Spring 1998

EECS 517
Image Processing
Spring 1998

EECS 517
Image Processing
Motorola Campus
Spring 1998

EECS 171
Introduction to Programming
Summer 1998

EECS 516
Optimal and Adaptive Digital Filters
Fall 1998

EECS 530
Statistical Communication Theory
Motorola Campus
Fall 1998

EECS 418
Digital Signal Processing II
Spring 1999

EECS 517
Image Processing
Spring 1999

EECS 531
Detection and Estimation Theory
Motorola Campus
Spring 1999

EECS 171
Introduction to Programming
Summer 1999

EECS 417

Digital Signal Processing I
Fall 1999

EECS 491
Multimedia Communication Networks
Spring 2000

EECS 311
Communication Engineering
Summer 2000

EECS 491
Multimedia Communication Networks
Internet Course (Preparation)
Fall 2000

EECS 516
Optimal and Adaptive Digital Filters
Fall 2000

EECS 531
Detection and Estimation Theory
Fall 2000

EECS 491
Multimedia Communication Networks
Internet Course
Spring 2001

EECS 517
Image Processing
Spring 2001

EECS 171
Introduction to Programming
Summer 2001

ECE 516
Optimal and Adaptive Digital Filters
Fall 2001

ECE 531
Detection and Estimation Theory
Fall 2001

ECE 434
Multimedia Communication Networks
Internet Course
Spring 2002

ECE 517

Image Processing
Spring 2002

CS 102
Introduction to Programming
Summer 2002

ECE 433
Computer Communication Networks
Fall 2002

ECE 434
Multimedia Communication Networks
Fall 2002

ECE 333
Computer Communication Networks
Laboratory (Preparation)
Spring 2003

ECE 311
Communication Engineering
Fall 2003

ECE 434
Multimedia Communication Networks
Fall 2003

ECE 517
Image Processing
Spring 2004

ECE 434
Multimedia Communication Networks
Fall 2004

ECE 516
Optimal and Adaptive Digital Filters
Fall 2004

ECE 517
Image Processing
Spring 2005

ECE 311
Communication Engineering
Summer 2005

ECE 434
Multimedia Systems
Fall 2005

ECE 516

Optimal and Adaptive Digital Filters
Fall 2005

ECE 517

Image Processing
Spring 2006

ECE 311

Communication Engineering
Summer 2006

ECE 434

Multimedia Systems
Fall 2006

ECE 516

Optimal and Adaptive Digital Filters
Fall 2006

ECE 531

Detection and Estimation Theory
Spring 2007

ECE 311

Communication Engineering
Summer 2007

ECE 434

Multimedia Systems
Fall 2007

ECE 516

Optimal and Adaptive Digital Filters
Fall 2007

ECE 531

Detection and Estimation Theory
Spring 2008

ECE 434

Multimedia Systems
Fall 2008

ECE 516

Optimal and Adaptive Digital Filters
Fall 2008

ECE 530

Random Signal Analysis

Spring 2009

ECE 517

Image Processing

Fall 2009

ECE/BIOE 407

Pattern Recognition

Spring 2010

ECE 434

Multimedia Systems

Fall 2010

ECE 530

Random Signal Analysis

Spring 2011

ECE 434

Multimedia Systems

Fall 2011

ECE 530

Random Signal Analysis

Spring 2012

ECE 594

Machine Learning

Spring 2012

ECE 434

Multimedia Systems

Fall 2012

ECE 517

Image Processing

Fall 2012

ECE 530

Random Signal Analysis

Spring 2013

ECE 434

Multimedia Systems

Fall 2013

ECE 517

Image Processing

Fall 2013

ECE 434

Multimedia Systems
Fall 2014

ECE 517
Image Processing
Fall 2014

ECE 434
Multimedia Systems
Fall 2015

ECE 517
Image Processing
Fall 2015

ECE 434
Multimedia Systems
Fall 2015

ECE 517
Image Processing
Fall 2015

ECE 407
Pattern Recognition
Spring 2016

ECE 530
Random Signal Analysis
Spring 2016

ECE 434
Multimedia Systems
Fall 2016

ECE 517
Image Processing
Fall 2016

ECE 407
Pattern Recognition
Spring 2017

ECE 434
Multimedia Systems
Fall 2017

ECE 517
Image Processing
Fall 2017

ECE 517

Image Processing
Spring 2018

ECE 530

Random Signal Analysis
Spring 2018

ECE 434

Multimedia Systems
Fall 2018

ECE 517

Image Processing
Fall 2018

ECE 530

Random Signal Analysis
Spring 2019

ECE 434

Multimedia Systems
Fall 2019

ECE 517

Image Processing
Spring 2020

ECE 530

Random Signal Analysis
Spring 2020

ECE 434

Multimedia Systems
Fall 2020

ECE 530

Random Signal Analysis
Spring 2021

ECE 531

Detection and Estimation Theory
Spring 2021

ECE 434

Multimedia Systems
Fall 2021

ECE 517

Image Processing
Fall 2021

ECE 530

Random Signal Analysis
Spring 2022

ECE 531

Detection and Estimation Theory
Spring 2022

ECE 434

Multimedia Systems
Fall 2022

ECE 517

Image Processing
Fall 2022

ECE 530

Random Signal Analysis
Spring 2023

ECE 434

Multimedia Systems
Fall 2023

ECE 517

Image Processing
Fall 2023

ECE 317

Digital Signal Processing I
Spring 2024

S.3. University of Trento**Content-Based Video Analysis: Tracking, Retrieval, and Classification**

Information and Communication Technology (ICT) – International Doctoral School
Department of Information Engineering and Computer Science
University of Trento
May 2010