

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NINTENDO CO., LTD., and
NINTENDO OF AMERICA INC.,
Petitioner

v.

POLARIS POWERLED TECHNOLOGIES, LLC,
Patent Owner

Case IPR2023-00778
U.S. Patent No. 8,223,117 B2

DECLARATION OF DR. ROBERT L. STEVENSON

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Polaris EX2030
Nintendo v. Polaris
IPR2023-00778

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I, Dr. Robert L. Stevenson, declare under penalty of perjury as follows:

I. INTRODUCTION AND BACKGROUND

1. I have been retained as an expert witness by Polaris PowerLED Technologies, LLC (“Polaris”) and have been asked to provide my expert opinions regarding U.S. Patent No. 8,223,117 (the “’117 patent”) and the prior art asserted against the ’117 patent in this *inter partes* review.

2. In this declaration I provide my independent analysis of the ’117 patent and the prior art in light of my knowledge and experience in this field during the relevant time frame. I have been asked to consider what one of ordinary skill in the art at the time of the invention of the ’117 patent (a “POSA”; refer to Section IV below) would have understood from the specification, including scientific and technical knowledge related to the patent. I have also been asked to consider whether certain references disclose or render obvious the invention described by claims 1-2, 7, 9, and 15-16 of the ’117 patent.

3. My findings, as explained below, are based on my study, experience, and background in the fields discussed below, informed by my education in electrical engineering. I have also relied on my review and analysis of the prior art, information provided to me, and information that I have independently reviewed.

4. I am being compensated for my independent analysis as an expert with respect to this *inter partes* review proceeding at my standard hourly rate of

\$700/hour but my compensation is not contingent in any way on the content of my analysis or the outcome of this proceeding. I have no financial interest in Petitioners (Nintendo Co., Ltd. and Nintendo of America Inc.) or Patent Owner (Polaris), and I have no financial interest in the challenged patent or this proceeding.

II. QUALIFICATIONS

5. Details of my professional qualifications and background are set out in my Curriculum Vitae attached hereto. As shown in my curriculum vitae, I have devoted my career to research and development in the fields of electrical engineering and computer science. I have a Bachelor of Science degree in Electrical Engineering from the University of Delaware and a Ph.D. degree in Electrical Engineering from Purdue University. My Ph.D. research was on communications and signal processing.

6. I am presently a Professor in the Department of Electrical Engineering at the University of Notre Dame. I first joined the faculty at the University of Notre Dame as an Assistant Professor in the Department of Electrical Engineering in 1990. I was granted tenure and promoted to the rank of Associate Professor in August 1996. I attained the rank of Professor in the Department of Electrical Engineering in August 2002, and I continue to serve in that capacity. From 2003 to

2017, I have served concurrently as a Professor in the Department of Computer Science and Engineering at the University of Notre Dame.

7. Several leading computing companies, including Intel, Sun Microsystems, Apple Computer, and Microsoft, have supported my research at Notre Dame. During the past 20 years, I have published over 150 technical papers in the field of electrical engineering.

8. I am a member of the Institute of Electronics and Electrical Engineers (IEEE), The International Society for Optical Engineering, and the Society for Imaging Science and Technology. I am also a member of the academic honor societies Eta Kappa Nu, Tau Beta Pi, and Phi Kappa Phi.

9. For the past 35 years, my work has focused on the design of techniques, hardware, and software for the processing of signals using digital computing devices. For example, my early work on digital techniques for signal processing devices led to significant interaction with companies developing desktop computer products in the early 1990s as they tried to incorporate my ideas into their products. I have also given a series of talks while at Intel's Architecture Lab on advanced communication and video processing techniques on the Pentium platform. In addition, the Air Force Research Laboratory funded my work to develop advanced parallel processing algorithms in an ad-hoc network of mixed computers to achieve significant gains in computational processing. As such, my

work has spanned a broad range of hardware and software topics, with a particular focus on signal processing and optics.

10. Because of my background, training, and experience, I am qualified as an expert in the technical areas relevant to the '117 patent.

III. MATERIALS CONSIDERED

11. In preparing this declaration, I have considered the claims, specification, and prosecution history of the '117 patent and its parent, U.S. Patent No. 7,468,722 ("722 patent"). As part of my analysis for this Declaration, I have considered my own knowledge and experience, including my work and experience with electrical engineering and computer science in the context of both analog (hardware) and digital (hardware and software) devices. Additional materials that I have reviewed in preparing this declaration include the Petition for *Inter Partes* Review filed by Petitioners Nintendo Co., Ltd. and Nintendo of America Inc. on March 28, 2023, as well as each of the exhibits to that Petition, several of which I discuss in detail below. I have also reviewed the Board's Institution Decision in this *inter partes* review. In addition, I have also reviewed the decision in the *ex parte* reexamination (EX2028) and relevant decisions in prior *inter partes* reviews of the '117 patent and relevant district court claim construction orders.

IV. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

12. I understand that the teaching of the prior art is viewed through the eyes of a POSA. Counsel for Polaris has informed me that a person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. In my opinion, the relevant field of art for the ’117 patent is that of electrical engineering and display technologies. I have also been informed by counsel for Polaris that the person of ordinary skill is generally familiar with the type of problems encountered in the field and the prior art solutions to those problems and possesses an ordinary level of creativity.

13. In my opinion, a person of ordinary skill in the art with respect to the ’117 patent at the time of the alleged invention would have had at least a bachelor’s degree in electrical engineering, physics, or computer science, or 2-4 years of experience in the field of visual displays and related technologies.

V. BACKGROUND OF THE ’117 PATENT

14. The ’117 patent is entitled “Method and Apparatus to Control Display Brightness with Ambient Light Correction.” The ’117 patent is directed to methods and apparatuses that control the brightness of a display device. Claim 1 is reproduced below.

1. A brightness control circuit with selective ambient light correction comprising:

a first input configured to receive a user signal indicative of a user selectable brightness setting;
a light sensor configured to sense ambient light and to output a sensing signal indicative of the ambient light level;
a multiplier configured to selectively generate a combined signal based on both the user signal and the sensing signal; and
a dark level bias configured to adjust the combined signal to generate a brightness control signal that is used to control a brightness level of a visible display such that the brightness control signal is maintained above a predetermined level when the ambient light level decreases to approximately zero.

EX1001, 12:27-43. “User [input] signal” is being used collectively for both “user signal” in claim 1 and “input signal” in claim 15. “Sensing signal” is being used collectively for both “sensing signal” in claim 1 and “sense signal” in claim 15.

15. As shown in claim 1, the '117 patent describes and claims a specific manner of controlling the brightness of a visible display involving a user [input] signal indicative of a user selectable brightness setting and a sensing signal indicative of the ambient light level to generate a combined signal, which is adjusted by a dark level bias value to ensure that the brightness control signal is maintained above a predetermined level when the ambient light level decreases to approximately zero.

16. The advantages of controlling display brightness in accordance with the '117 patent include an increase in the battery life of a device, extending the life of the light source for the display screen giving the device a longer lifetime, and providing a better user viewing experience. EX1001, 1:37–50, 2:47–53.

17. The text and Figures of the '117 patent show multiple different embodiments. Figure 1 depicts a first embodiment of the invention. In Figure 1, a dark level bias, a sensing signal output by the device's light sensor, and a user signal indicative of a user selectable brightness setting (referred to as “dimming control”) are all used to create a brightness control signal. EX1001, FIG. 1, 4:45–5:14. Figure 1 depicts three scaling factors labeled K1 (100), K2 (102), and K3 (108) that process and change the dark level bias, the sensing signal output by the ambient light sensor, and the combined signal. *Id.*

FIG. 1

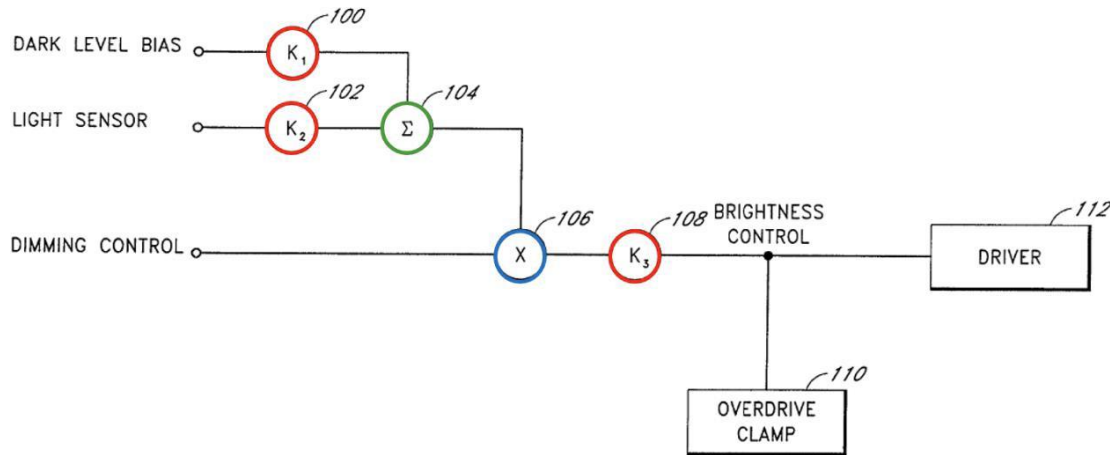
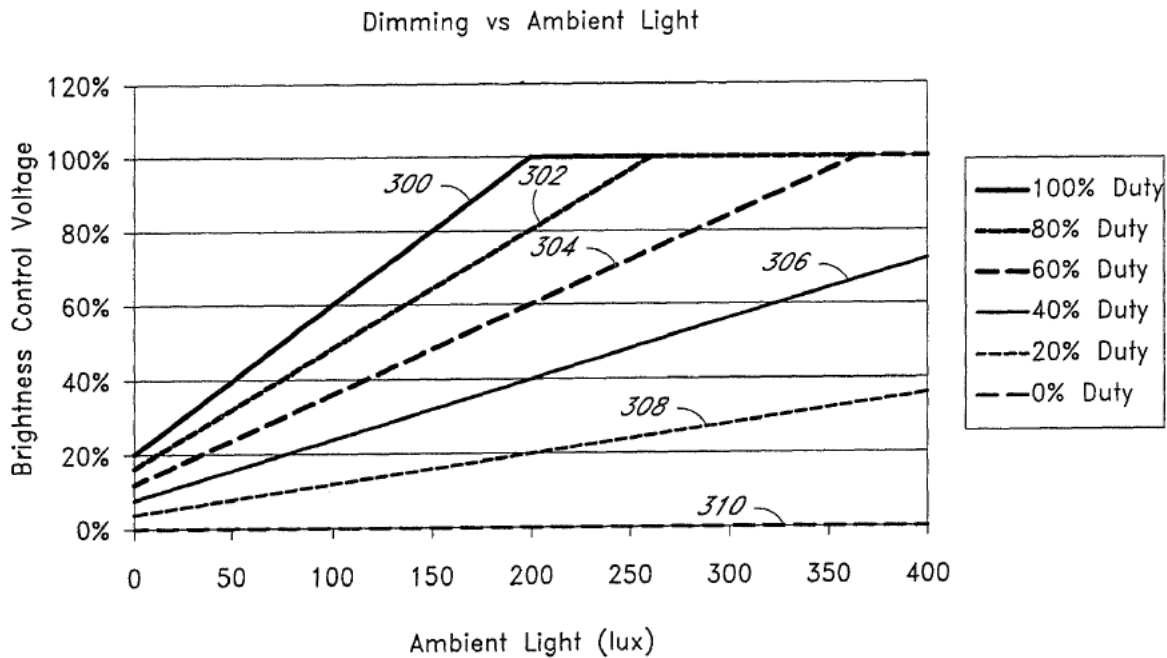


FIG. 1 is a block diagram of one embodiment of a brightness control circuit with ambient light correction. A user input (DIMMING CONTROL) is multiplied by a sum of a dark level bias (DARK LEVEL BIAS) and a light sensor output (LIGHT SENSOR) to produce a brightness control signal (BRIGHTNESS CONTROL) for a display driver 112. In one configuration, the dark level bias and the light sensor output are adjusted by respective scalar circuits (k_1 , k_2) 100, 102 before being added by a summing circuit 104. An output of the summing circuit 104 and the user input is provided to a multiplier circuit 106. An output of the multiplier circuit 106 can be adjusted by a third scalar circuit (k_3) 108 to produce the brightness control signal. An overdrive clamp circuit 110 is coupled to the brightness control signal to limit its amplitude range at the input of the display driver 112.

EX1001, FIG. 1 (annotated), 4:46-61.

18. Figure 1's dark level bias performs a mathematical adjustment to the combined signal by being added to the sensing signal from the ambient light sensor at 104. EX1001, FIG. 1, 4:45-5:14. The sum is then multiplied by the "dimming control," which is the user [input] signal indicative of a user selectable brightness setting recited in claim 1 in order to form the brightness control signal. *Id.* Figure 1 also shows the overdrive clamp circuit (110) that limits the range of the brightness control signal's amplitude. *Id.* As in all embodiments, the dark level bias serves to make the brightness control signal positive and maintains it above a predetermined level when the ambient light is approximately zero. Some light sensors, as is common, may output a non-zero signal when the ambient light level is approximately zero, while others may output a zero signal. The dark level bias is configured to appropriately adjust the combined signal in all such cases.

19. Figure 3 illustrates a graph of brightness control signals as a function of ambient light levels for different user settings. EX1001, FIG. 3, 5:44-6:21. On the left side of Figure 3, at 0 lux of ambient light, the effect of the dark level bias in maintaining a minimum brightness control signal (partially as a function of the user [input] signal) is visible.



Graph 300 shows a first brightness control signal as a function of ambient light level given a first user setting (e.g., 100% duty cycle PWM dimming input). Graph 302 shows a second brightness control signal as a function of ambient light level given a second user setting (e.g., 80% duty cycle PWM dimming input). Graph 304 shows a third brightness control signal as a function of ambient light level given a third user setting (e.g., 60% duty cycle PWM dimming input). Graph 306 shows a fourth brightness control signal as a function of ambient light level given a fourth user setting (e.g., 40% duty cycle PWM dimming input). Graph 308 shows a fifth brightness control signal as a function of ambient light level given a fifth user setting (e.g., 20% duty cycle PWM dimming input). Finally, graph 310 shows a sixth brightness control signal as a function of ambient light level given a sixth user setting (e.g., 0% duty cycle PWM dimming input).

EX1001, FIG. 3, 5:52-67.

20. Figure 2 depicts a second embodiment of the invention. Figure 2 shows that the brightness control signal is created using a dark level bias, a sensing signal output by the light sensor, and a user [input] signal indicative of a user selectable brightness setting (also referred to as a “dimming control,” as in the Figure 1 embodiment). EX1001, FIG. 2, 5:15-43. Like the Figure 1 embodiment, in Figure 2, K1 (100), K2 (102), and K3 (108) are scaling factors that process and change the dark level bias, the sensing signal, and the combined signal. *Id.*

FIG. 2

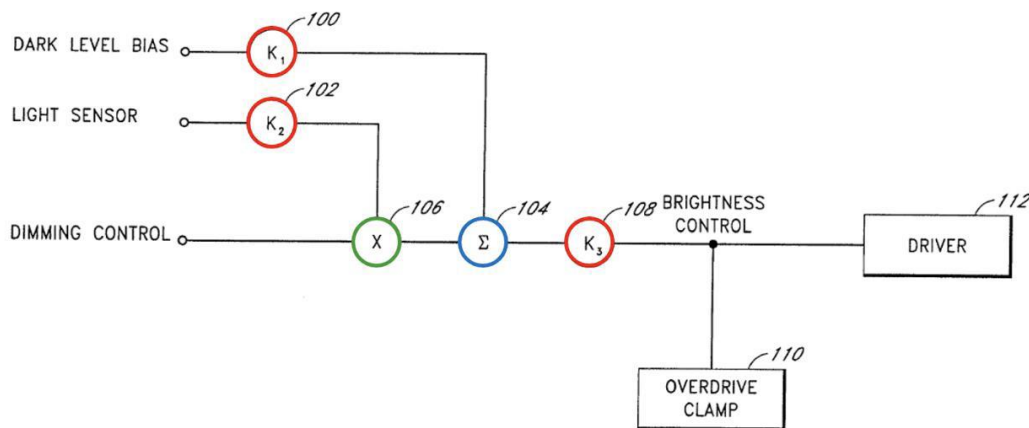


FIG. 2 is a block diagram of another embodiment of a brightness control circuit with ambient light correction. A light sensor output (LIGHT SENSOR) is adjusted by a scalar circuit (k₂) 102 and then provided to a multiplier circuit 106. A user input (DIMMING CONTROL) is also provided to the multiplier circuit 106. The

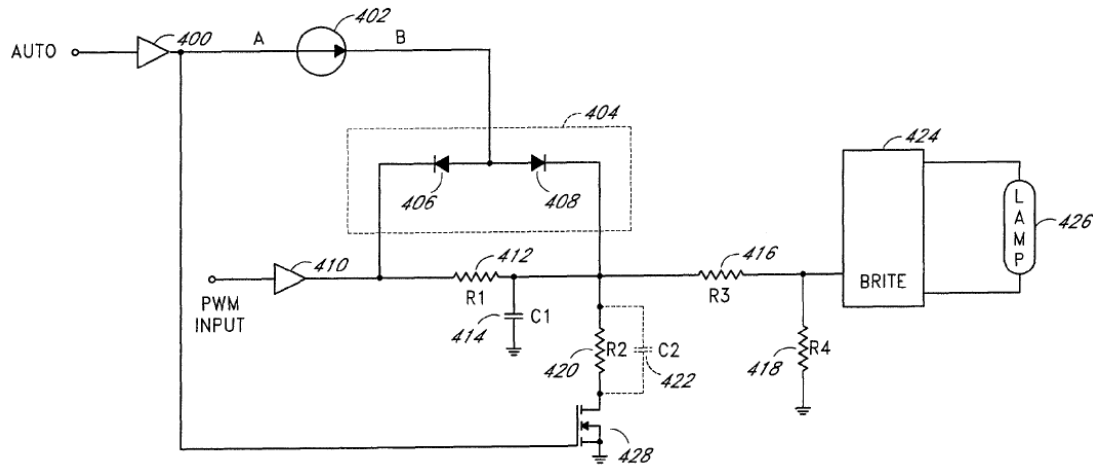
multiplier circuit 106 outputs a signal that is the product of the user input and scaled light sensor output. A summing circuit 104 adds the product to a dark level bias (DARK LEVEL BIAS) that has been adjusted by scalar circuit (k1) 100. An output of the summing circuit 104 is adjusted by scalar circuit (k1) 100. An output of the summing circuit 104 is adjusted by scalar circuit (k3) 108 to generate a brightness control signal (BRIGHTNESS CONTROL) for a display driver 112. An overdrive clamp 110 is coupled to the brightness control signal to limit its amplitude range at the input of the display driver 112.

EX1001, FIG. 2 (annotated), 5:15-29.

21. In Figure 2, the scaled sensing signal is multiplied by the “DIMMING CONTROL,” which is a user [input] signal indicative of a user selectable brightness setting. After this multiplication, a dark level bias is added to mathematically adjust the combined signal. The result is then scaled and becomes the brightness control signal. EX1001, FIG. 2, 5:15-43.

22. Figure 4 shows another embodiment of the system of the '117 patent. In this embodiment, the brightness control circuit is operable in either an automatic mode or a manual mode. EX1001, FIG. 4, 7:3-8:9. The Figure 4 brightness control circuit has a multiplier circuit to combine the light sensor output with a user-adjustable PWM signal. EX1001, FIG. 4, 6:22-8:9.

FIG. 4



23. When the Figure 4 embodiment is operating in automatic mode, the equation used for the calculation of the brightness control signal (or “BCS”) is as follows:

$$BCS1 = \text{User [Input] Signal} \times \left[\left(\frac{VCC \times R2 \times R4}{[(R1 + R2) \times (R3 + R4)] + (R1 \times R2)} \right) + \text{Sensing Signal} \left(\frac{ISRC \times R1 \times R2 \times R4}{[(R1 + R2) \times (R3 + R4)] + (R1 \times R2)} \right) \right]$$

The term “duty cycle” corresponds to the duty cycle of the user adjustable PWM logic signal. The term “VCC” corresponds to the logic high output from the input buffer circuit 410. The term “ISRC” corresponds to the sensor current signal. The first major term within the brackets corresponds to a scaled dark bias level of the brightness

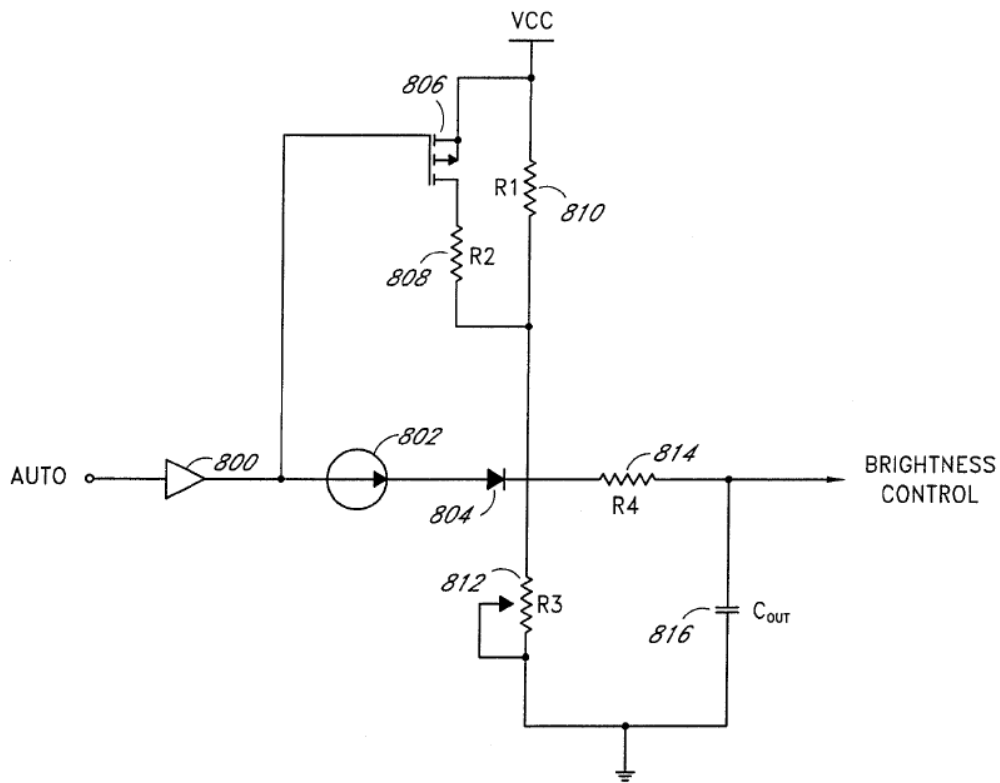
control signal in total ambient darkness. The second major term within the brackets introduces the effect of the visible light sensor 402. The network of resistors 412, 420, 416, 418 helps to provide the dark bias level and to scale the product of the sensor current signal and the user adjustable PWM logic signal.

EX1001, FIG. 4 (annotated), 7:3-47. While the equation provided for the preferred embodiment of Figure 4 shows a mathematical model for the brightness control signal output by the circuit, the analog circuit in Figure 4 actually performs the math concurrently rather than sequentially.

24. In the above formula, ISRC represents the sensing signal. *Id.* The “duty cycle” corresponds to the user [input] signal indicative of the user selectable brightness setting. *Id.* In the equation, R1-R4 are the values of resistors that scale the ISRC sensor current signal in the second bracketed term. The dark level bias is the first bracketed term, which includes “VCC.” *Id.* The scaled dark level bias is comprised of several values, including VCC, R1, R2, R3, and R4. *Id.* In the Figure 4 embodiment, the scaled dark level bias performs a mathematical adjustment to the combined signal by being added to the scaled sensing signal concurrently with multiplication by the “duty cycle,” which is the user [input] signal. *Id.*

25. Figure 8 shows another embodiment of the '117 patent. Like the Figure 4 embodiment, the Figure 8 embodiment can operate in an automatic or manual mode. EX1001, FIG. 8, 9:38-10:32.

FIG. 8



EX1001, FIG. 8.

26. When operating in automatic mode, the brightness control signal is calculated using the below equation. EX1001, 9:61-10:19.

$$BCS3 = \left[\overset{\text{Dark Level Bias}}{VCC \times \frac{R3}{(R1 + R3)}} \right] + \left[\overset{\text{Sensing Signal}}{ISRC} \times \overset{\text{User [Input] Signal}}{\frac{(R1 \times R3)}{(R1 + R3)}} \right]$$

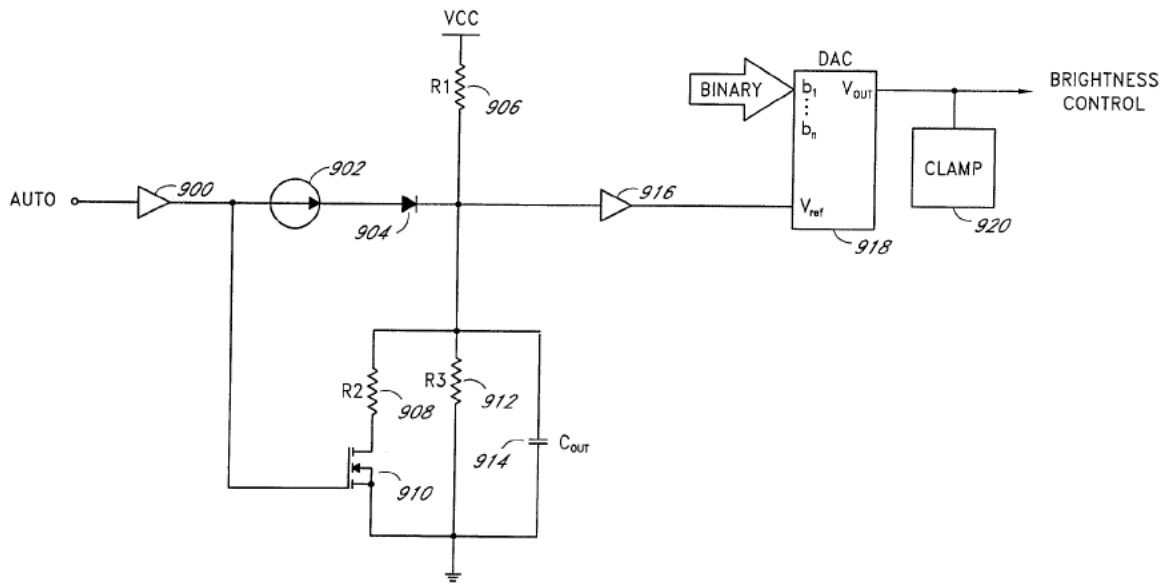
The first major term in the brackets of the above equation corresponds to the brightness control signal in total ambient darkness. The second major term in brackets introduces the effect of the visible light sensor

802. The maximum range for the brightness control signal in the auto mode is determined by the compliance voltage of the visible light sensor 802.

EX1001, 10:10-19 (annotated). While the equation provided for the preferred embodiments of Figure 8 shows a mathematical model for the brightness control signal output by the circuit, the analog circuit in Figure 8 actually performs the math concurrently rather than sequentially.

27. The second major term in brackets above, which includes ISRC, “introduces the effect of the visible light sensor.” *Id.* This term is the “sensing signal” recited in the claims. EX1001, FIG. 8, 9:38-10:19. The term R3 represents an input from the user indicating a user selectable brightness setting. *Id.* R1 and R2 are the values of resistors. *Id.* The dark level bias is the first term in brackets above, and is made up of VCC, R1, and R3. *Id.* The dark level bias in Figure 8 mathematically adjusts the combined signal concurrently with the multiplication.

28. Figure 9 shows yet another embodiment of the '117 patent. Figure 9 is a brightness control circuit with a multiplier that combines the output of the light sensor with a user-adjustable digital word. EX1001, FIG. 9, 10:33-11:26. Like the Figure 4 and Figure 8 embodiments, the Figure 9 embodiment is operable in either an automatic mode or a manual mode. *Id.*



29. The brightness control signal calculation, when the Figure 9 embodiment is operating in automatic mode, is performed as follows:

$$BCS5 = \text{User [Input] Signal} \times \left[\left(\frac{VCC \times (R2 \times R3) + [ISRC] \times R1 \times R2 \times R3}{(R1 \times R2) + (R1 \times R3) + (R2 \times R3)} \right) \right]$$

User [Input] Signal Dark Level Bias Sensing Signal

EX1001, 11:10-15 (annotated). While the equation provided for the preferred embodiments of Figure 9 shows a mathematical model for the brightness control signal output by the circuit, the analog circuit in Figure 9 actually performs the math concurrently rather than sequentially.

30. The “binary % fullscale” corresponds to the user [input] signal indicative of a user selectable brightness setting. EX1001, FIG. 9, 10:33-11:26. A binary word, or digital word, is a series of ones and zeroes, representing a binary

value generated by the device software, separate from, but indicative of, a brightness setting entered by a user. ISRC represents the sensing signal output by the light sensor. *Id.* R1-R3 are the values of resistors. *Id.* The term highlighted above in the green box represents the dark level bias, which includes the values of VCC, R1, R2, and R3. *Id.* The dark level bias in Figure 9 again mathematically adjusts the combined signal by being added to the sensing signal concurrently with the multiplication. *Id.*

31. Taken together, the embodiments of the '117 patent show that the “multiplier” that generates the “combined signal” of the '117 patent is not simply limited to the direct product of the user [input] signal and the sensing signal. Rather, numerous embodiments show a variety of scaling factors and other adjustments to the components of the combined signal.

32. In contrast to prior art systems, the '117 patent's system utilizes a biasing scheme that mathematically adjusts other signals via the “dark level bias.” A dark level bias in the '117 patent can be implemented in more than one way. The Figure 1 embodiment shows that this adjustment to the combined signal is performed by addition to the sensing signal via a summing circuit 104 prior to multiplication. EX1001, FIG. 1, 4:46-61. In doing so, the output of the multiplier is modified to maintain it above a predetermined level wherein the amount of adjustment to the combined signal is partially determined by the user [input]

signal. Figure 3 shows that the minimum brightness changes as the user [input] signal increases. EX1001, FIG. 3. The embodiments of Figures 4 and 9 similarly adjust the combined signal concurrently with the multiplication of the user and sensing signal. EX1001, FIG. 4, 7:3-47. The Figure 2 embodiment, for example, implements the dark level bias after the user [input] signal and sensing signal are multiplied by multiplier circuit 106, via summing circuit 104. EX1001, FIG. 2. The Figure 8 embodiment shows the dark level bias adjusting the combined signal concurrently with multiplication.

33. Importantly, all of these implementations of the “dark level bias,” whether prior to, concurrently, or after the multiplication of the user and sensing signal, serve to adjust the combined signal to produce a brightness control signal that is maintained above a predetermined level when the ambient light level decreases to approximately zero, as recited in the claims. And, similarly importantly, all of these implementations of the “dark level bias” are more than a simple minimum or a replacement of the combined signal with a minimum value. Specifically, each embodiment utilizes the dark level bias as a mathematical *adjustment* to the combined signal in order to *produce* the brightness control signal.

VI. CLAIM CONSTRUCTION

A. “light sensor”

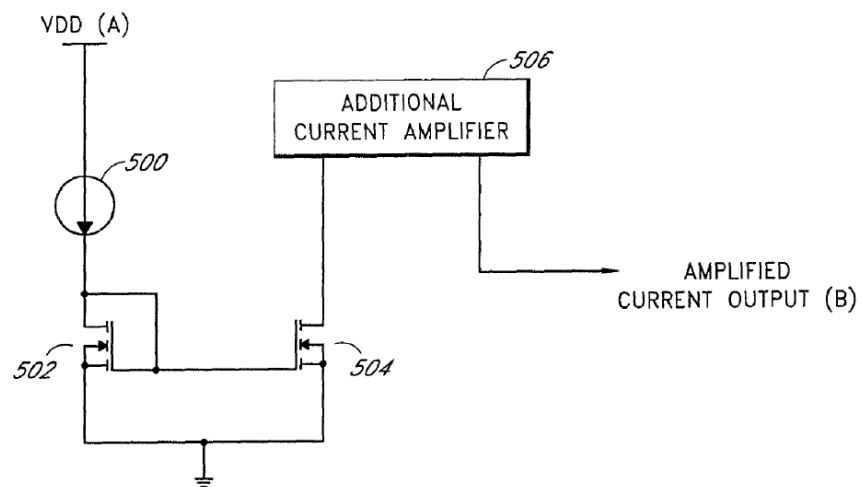
34. I have reviewed the Board’s Institution Decision and understand that a question has been raised as to the proper construction of the term “light sensor” found in the ’117 patent’s claim 1. It is my opinion that the term “light sensor” had a plain and ordinary meaning to a POSA at the time of the invention, which is a sensor that detects ambient light and outputs a signal indicative of the ambient light level.

35. Light sensors are and were, at the time of the invention, a well-known, standard, off-the-shelf component that a POSA could easily purchase from a variety of sources, such as catalogs, the internet, or electronics suppliers, similar to other standard electrical components like capacitors, resistors, transistors, and the like. Prior to the time of the invention, such light sensors were widely available. *See*, for example, EX2033, 1; EX2037, 1084, 1088, 1095. In fact, Microsemi, to whom the ’117 patent was assigned, also marketed and sold visible light sensors such as the LX1970 and LX1971. EX2038, EX2039. While light sensors at the time of the invention took different forms, such as photoresistors, photodiodes, phototransistors, or other components, all operated under the same basic principles. Namely, a light sensor is a component that reacts to the presence of ambient light, and outputs some form of signal that is indicative of the amount of light incident

on the sensor. While the resulting signal may be used for a variety of purposes, it is nonetheless indicative of the level of light contacting the sensor.

36. This understanding is consistent with the descriptions of light sensors in the '117 patent, which accurately reflects the understanding of a POSA at the time of the invention. For example, the '117 patent shows several different arrangements of standard components that comprise light sensor circuits. Figure 5 of the '117 patent illustrates a light sensor circuit which includes a pair of transistors and a current amplifier:

FIG. 5

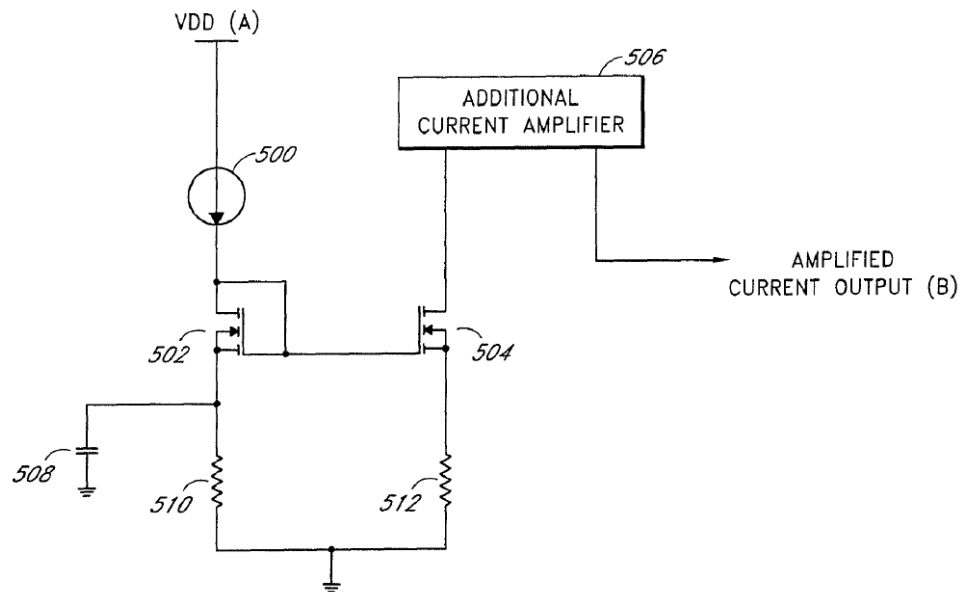


EX1001, FIG. 5; *see also id.*, 8:10-21.

Similarly, Figure 6 depicts a light sensor circuit that, while “substantially similar to the ambient light sensor of FIG. 5,” “further includes a program capacitor 508 and

source degeneration resistors 510, 512” (EX1001, 8:41-52) in order to provide an adjustable response time:

FIG. 6



EX1001, FIG. 6.

37. As I discuss further in Section VIII.A below, while a light sensor may include components in addition to the light detector itself (like the program capacitor in Figure 6, or the amplifier circuits in Figures 5 and 6) these components are part of the light sensor, consistent with a POSA’s understanding of the nature of such a component. A POSA would not consider components entirely separate from the light sensor circuit, such as a microprocessor or software running on the device, to be a part of or comprise a light sensor.

B. “multiplier” and “multiplying”

38. I have reviewed the claim construction order in *Polaris PowerLED Technologies, LLC v. Samsung Electronics America, Inc. et al.*, Case No. 2:17-cv-00715-JRG (EX2001). It is my opinion that Patent Owner’s proposed construction is consistent with that order in requiring that claim 1’s “multiplier” (and the “multiplying” limitation of claim 15) require multiplication. EX2001, 29-30.

39. It is my opinion that, based on my experience in the fields of electrical engineering and computer science at the time of the invention, a POSA would in fact have understood “multiplier”/“multiplying” to suggest actual multiplication. Such an interpretation is consistent with the intrinsic evidence, which clearly and consistently shows the multiplier performing multiplication involving the user signal and the sensing signal, including for example Figures 4, 8, and 9. The brightness control signal equations associated with these figures are respectively annotated below to show the relevant claim elements in each formula. In each case, the user signal is multiplied with the sensing signal. Though there are scaling factors in each equation that are also involved in the multiplication, the specification and figures make clear that “multiplier”/“multiplying” requires multiplication, which is consistent with the understanding of a POSA at the time of the invention.

$$\begin{aligned}
 BCS1 &= \text{User Signal } \boxed{\text{duty cycle}} \times \left[\left(\frac{VCC \times R2 \times R4}{[(R1 + R2) \times (R3 + R4)] + (R1 \times R2)} \right) + \right. \\
 &\quad \left. \text{Sensing Signal } \left(\frac{\boxed{ISRC} \times R1 \times R2 \times R4}{[(R1 + R2) \times (R3 + R4)] + (R1 \times R2)} \right) \right] \\
 BCS3 &= \left[\frac{VCC \times R3}{(R1 + R3)} \right] + \left[\text{Sensing Signal } \boxed{ISRC} \times \frac{(R1 \times \boxed{R3})}{(R1 + R3)} \right] \\
 BCS5 &= \text{User Signal } \boxed{\text{binary \% fullscale}} \times \left[\left(\frac{VCC \times (R2 \times R3)}{(R1 \times R2) + (R1 \times R3) + (R2 \times R3)} \right) + \right. \\
 &\quad \left. \text{Sensing Signal } \left(\frac{\boxed{ISRC} \times R1 \times R2 \times R3}{(R1 \times R2) + (R1 \times R3) + (R2 \times R3)} \right) \right]
 \end{aligned}$$

EX1001, 7:17-32, 10:9-12, 11:10-15 (annotated).

40. It is thus my opinion that the term “multiplier” in claim 1 and “multiplying” in claim 15 would have been readily understood by a POSA, particularly in the context of the intrinsic evidence, to require multiplication involving the user signal and sensing signal, and such a construction would be consistent in my opinion with the construction given by the Court in the *Polaris v. Samsung* matter.

C. “dark level bias”

41. I have reviewed the prosecution history of the *ex parte* Reexamination of the ’117 patent, Control No. 90/019,119, and understand that it is the USPTO’s

determination that the term “dark level bias” is “a signal value, such as a voltage value or value of a software variable, that mathematically adjusts the value of the combined signal when the ambient brightness is low, which excludes a threshold or minimum brightness level that overrides, substitutes for, or replaces the combined signal with another value.” EX2028, 4-5, 16, 17. I understand that the Patent Owner proposes the same construction in this *inter partes* review. I have further reviewed the constructions of the district court in EX2002, 28, 34, in which the court construed “dark level bias” as “a value that causes a deviation from the combined signal, where the value is a voltage value of an electrical signal or value of a software variable” and recognized the “mathematical equation” from the ’117 patent as instructive in understanding the term. *Id.*, 24.

42. It is my opinion that the USPTO’s construction from the reexamination is consistent with the intrinsic evidence in the ’117 patent’s specification and figures and is consistent with the prior construction by the district court. As I discussed above, the specification describes the “dark level bias” multiple times across many unique embodiments. However, each embodiment is similar in that the dark level bias mathematically adjusts the combined signal to produce the brightness control signal. In Figure 1, for example, a dark level bias, a sensing signal output by the device’s light sensor, and a user signal indicative of a user selectable brightness setting used to create a brightness control signal.

EX1001, FIG. 1, 4:45-5:14. In the Figure 1 embodiment, consistent with claim 17, the dark level bias is added to the sense signal prior to multiplication. Importantly, that dark level bias serves as a mathematical adjustment (due to its addition to the sensing signal by summing circuit 104) to the value of the combined signal resulting from the multiplication of the user signal and adjusted sensing signal by multiplier 106.

FIG. 1

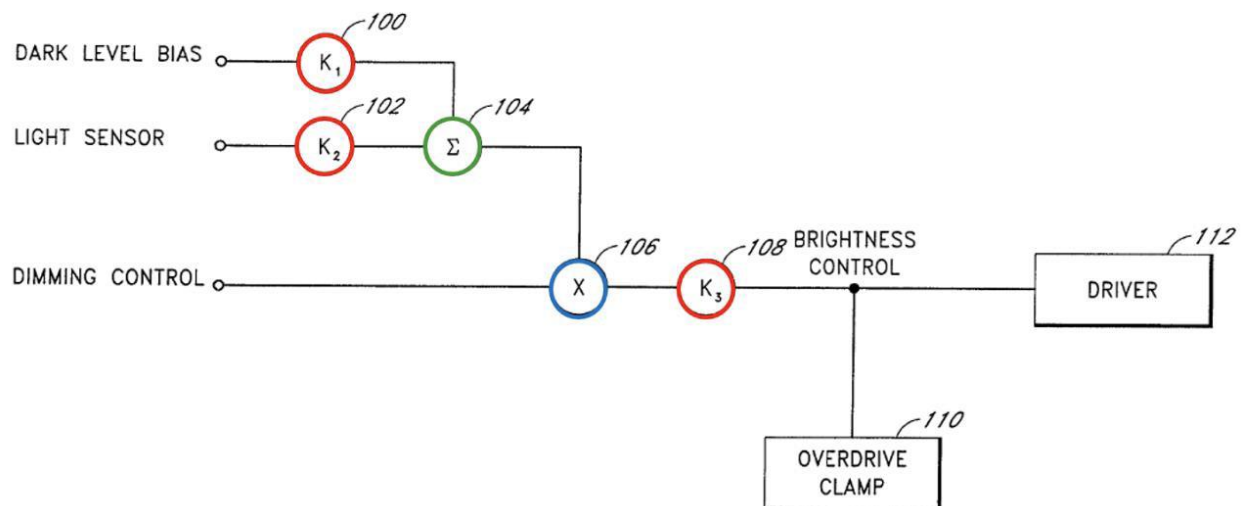


FIG. 1 is a block diagram of one embodiment of a brightness control circuit with ambient light correction. A user input (DIMMING CONTROL) is multiplied by a sum of a dark level bias (DARK LEVEL BIAS) and a light sensor output (LIGHT SENSOR) to produce a brightness control signal (BRIGHTNESS CONTROL) for a display driver 112. In one configuration, the dark level bias and the

light sensor output are adjusted by respective scalar circuits (k_1 , k_2) 100, 102 before being added by a summing circuit 104. An output of the summing circuit 104 and the user input is provided to a multiplier circuit 106. An output of the multiplier circuit 106 can be adjusted by a third scalar circuit (k_3) 108 to produce the brightness control signal. An overdrive clamp circuit 110 is coupled to the brightness control signal to limit its amplitude range at the input of the display driver 112.

EX1001, FIG. 1, 4:46-61 (annotated).

43. The Figure 2 embodiment is similar. In the Figure 2 embodiment, a dark level bias, a sensing signal output by the device's light sensor, and a user signal indicative of a user selectable brightness setting used to create a brightness control signal. EX1001, FIG. 2, 5:15-5:29. In the Figure 2 embodiment, the sensing signal and user signal are multiplied by multiplier 106, before the dark level bias is added to the resulting combined signal by summing circuit 104 to produce the brightness control signal. Again, as with the Figure 1 embodiment, that dark level bias serves as a mathematical adjustment to the value of the combined signal. Rather than simply being a replacement of that signal, the dark level bias is a value that actually adjusts the combined signal to produce a new value.

FIG. 2

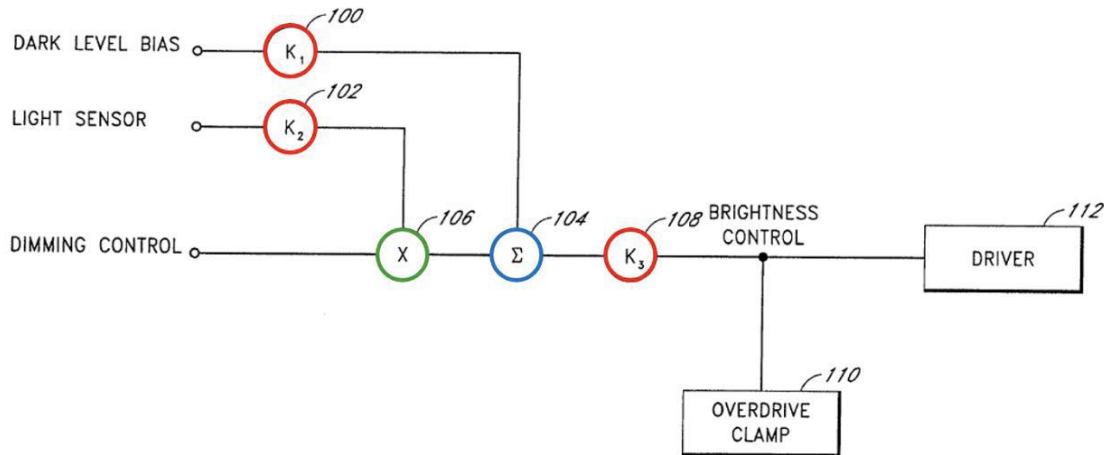


FIG. 2 is a block diagram of another embodiment of a brightness control circuit with ambient light correction. A light sensor output (LIGHT SENSOR) is adjusted by a scalar circuit (k_2) 102 and then provided to a multiplier circuit 106. A user input (DIMMING CONTROL) is also provided to the multiplier circuit 106. The multiplier circuit 106 outputs a signal that is the product of the user input and scaled light sensor output. A summing circuit 104 adds the product to a dark level bias (DARK LEVEL BIAS) that has been adjusted by scalar circuit (k_1) 100. An output of the summing circuit 104 is adjusted by scalar circuit (k_1) 100. An output of the summing circuit 104 is adjusted by scalar circuit (k_3) 108 to generate a brightness control signal (BRIGHTNESS CONTROL) for a display driver 112. An overdrive clamp 110 is coupled to the brightness control signal to limit its amplitude range at the input of the display driver 112.

EX1001, FIG. 2, 5:15-29 (annotated). Similarly, the embodiments of Figures 4, 8, and 9 show that the dark level bias mathematically adjusts the combined signal. EX1001, 7:17-32, 10:9-12, 11:10-15, FIGs. 4, 8, 9. There are no descriptions or embodiments in the '117 patent that show comparing the combined signal to a minimum threshold and replacing the signal with another value if it is below that threshold.

44. During the *ex parte* reexamination, the Patent Owner made several statements clarifying that dark level bias meant “a signal value, such as a voltage value or value of a software variable, that mathematically adjusts the value of the combined signal when the ambient brightness is low, which excludes a threshold or minimum brightness level that overrides, substitutes for, or replaces the combined signal with another value.” For example, the Patent Owner stated the following in overcoming the prior art in the *ex parte* reexamination.

Further, Whitted's threshold minimum power level is *not “dark level bias” because a “dark level bias” is a mathematical adjustment* and not a hard minimum as in Whitted.

Moreover, Whitted's *threshold minimum power level is not a “dark level bias” because a “dark level bias” is a mathematical adjustment* and not a hard minimum as in Whitted.

Importantly, the *“dark level bias” is used to mathematically adjust* the value of the combined signal in generating the brightness control

signal. Therefore, it is ***not a threshold or hard minimum, which would replace a signal***. Rather, the ***“dark level bias” is a signal value that mathematically adjusts the value of the combined signal*** to create the “brightness control signal.”

The ***dark level bias again mathematically adjusts*** the combined signal . . . Importantly, the ***dark level bias is a mathematical adjustment and not a hard minimum or threshold*** in any embodiment, including Figures 1 and 2.

The ***dark level bias thus mathematically adjusts*** the combined signal and is ***not a hard minimum or threshold brightness***.

The ***dark level bias*** is thus a bias that performs a ***mathematical adjustment*** and ***not a hard minimum or threshold brightness value***.

The claims further confirm that the ***dark level bias performs a mathematical adjustment*** (e.g., added to) and is thus ***not a hard minimum or predefined threshold brightness***.

Therefore, the specification and claims of the '117 patent are unambiguous that the ***“dark level bias” performs a mathematical adjustment*** to the combined signal and is ***not a hard minimum or predefined threshold***.

Specifically, ***Pioneer teaches having a preset minimum brightness that overrides or replaces any brightness calculation***. Such ***minimum thresholds are not a “dark level bias” because they do not perform a mathematical adjustment*** of brightness signals.

The fact that the line becomes “parallel” to the x-axis [in Pioneer reference] indicates that the ***minimum would replace any calculated brightness value with a preset value, which is a substitution for, not a mathematical adjustment of***, any calculated brightness value.

The ***“minimum power level” in Whitted is not a “dark level bias” because it does not perform any mathematical adjustment of a combined signal. It is a “pre-programmed” minimum threshold that overrides or replaces (rather than mathematically adjusts) the signal.***

[T]he claims require a “dark level bias” that adjusts the “combined signal” to generate a “brightness control signal.” ***The “preprogrammed” “minimum power level” in Whitted does not mathematically adjust any signal. Rather, it overrides or replaces the signal, which is not a mathematical adjustment to the signal.***

The ***“pre-programmed” “minimum power level” in Whitted is not a “dark level bias.”*** A bias is a value (e.g., voltage value of signal or the value of a software variable or function) that is used to ***mathematically adjust*** signals in a system into the desired operating range. In contrast, the “minimum power level” is a “pre-programmed” setting that ***overrides or replaces (rather than mathematically adjusts) the calculated brightness signal.***

With regard to the alleged “dark level bias,” Whitted does not disclose or suggest the “pre-programmed” “minimum power level” (i.e., the alleged “dark level bias”) as mathematically “adjusting” any signals . .

. The *“minimum power level” thus substitutes or replaces the signal from the brightness “function”* at low ambient light levels *rather than mathematically “adjusting” the signal* from the brightness “function.”

EX2027 (Response to Non-Final Office Action, dated Aug. 2, 2023), 2, 6, 9, 11, 13, 18, 19, 38-39, 54-55, 60-62 (internal citations omitted).¹

45. It is thus my opinion that the intrinsic evidence makes abundantly clear to a POSA that the “dark level bias” of the ’117 patent is a particular signal with a value, and that value is used to mathematically adjust the value of the combined signal, rather than a mechanism by which another value is substituted for the combined signal. Accordingly, it is my opinion that Patent Owner’s proposed construction of “dark level bias” as “a signal value, such as a voltage value or value of a software variable, that mathematically adjusts the value of the combined signal when the ambient light level is low, which excludes a threshold or minimum brightness level that overrides, substitutes for, or replaces the combined signal with another value” is most consistent with the disclosures of the ’117 patent.

VII. GROUNDS 1 AND 2

46. I have reviewed the Petition and the Declaration of Dr. Baker regarding Grounds 1 and 2 of the Petition, as well as the Stoughton, Mierzwinski,

¹ All emphasis added unless otherwise stated.

and Nagai references utilized in Ground 1 and the Shimomura reference in Ground 2. It is my opinion that the Petition's combinations fail to disclose or render obvious claims 1-2, 7, 9, and 15-16 for the reasons explained below.

A. “A User [Input] Signal Indicative of a User Selectable Brightness Setting.”

47. I understand that the Petition asserts that the combination of Stoughton, Mierzwinski, and Nagai discloses or, in the alternative, renders obvious “a user [input] signal indicative of a user selectable brightness setting.” Pet., 17. Namely, Stoughton's “viewer selected contrast level” is used because the Stoughton reference discloses no brightness controls. In fact, the Stoughton reference does not even mention the term “brightness,” because Stoughton only discusses adjustments to picture contrast. *See, e.g.,* EX1003, Abstract (“In a television receiver, a contrast control signal for controlling the amplitude of a video signal . . .”). Petitioner and Dr. Baker appear to premise this theory on the idea that Stoughton's “viewer selected contrast level” is a “user signal”/“user input signal” of claims 1 and 15, because adjustments to contrast are supposedly also adjustments to brightness. Pet., 17.

48. This theory is fundamentally incorrect. A POSA would readily understand that “brightness” and “contrast” are very different settings in the context of visible displays. As explained in “Basic Televisions and Video

Systems” by Bernard Grob (“Grob”), brightness is “the overall, or average, intensity of illumination and it determines the background level in the reproduced picture.” EX2004, 34-35. Contrast, however, is a different concept. Contrast is “the difference in intensity between black parts and white parts of the reproduced picture.” *Id.* Accordingly, contrast represents a ratio between the maximum and minimum brightness values of the picture, a definition supported by Petitioner’s Fink reference. EX1008, 58. Critically, because contrast is a ratio between the brightest and darkest parts of an image, the same contrast ratio can exist for many levels of brightness. Because these are different settings, a user can adjust the contrast ratio separately from the brightness, and adjusting one does not adjust the other.

49. I also note that RCA, which I understand to be a related entity to RCA Licensing Corporation to which Stoughton is assigned, is itself a manufacturer of CRT televisions. In manuals of RCA CRT televisions, the on-screen display reproduced in the manual as well as the manual itself clearly show “Brightness” and “Contrast” as separate settings, describing them in a way consistent with Grob. An excerpt from an RCA CRT manual is reproduced below:



The Picture Menu

The Picture Quality menu contains five slider controls that adjust the TV's picture. Use the CH ^/v to select an item, and use the VOL +/- adjust the controls.

Brightness Adjusts the brightness of the picture.

Contrast Adjusts the difference between light and dark areas of the picture.

Colour Adjusts the richness of the color.

Sharpness Adjusts the crispness of edges in the picture.

Magic Toggles between four preset picture settings:

Personal Sets the picture quality to the settings you've defined.

Original Returns the picture settings to their factory presets.

- Brightness Sets the picture to a darker overall level.

+ Brightness Sets the picture to a brighter overall level.

EX2006, 12 (annotated); see also EX2007, 22-23.

50. Petitioner seems to provide only a single definition substantiating the idea that adjusting contrast necessarily adjusts brightness, which is a definition provided inside of the Fink reference. EX1008, 51. That definition is sourced from a 1948 publication by the Institute of Radio Engineers. EX1008, 48. The date of this publication—over 50 years prior to the invention of the '117 patent—is critical. Namely, the nature of cathode ray tube (CRT) displays in 1948 was manifestly different than the nature of those displays in 2004. The ability to adjust the contrast and brightness of an image separately was a technique resolved long before the invention of the '117 patent, and a POSA at the time of the invention would not have understood these concepts to be equivalent or even similar. While adjustments to contrast and brightness may have affected each other circa 1948, this was no longer true at the time of the invention.

51. The mechanisms for contrast control and brightness control in CRT displays are distinctly different. The control of the contrast of a video signal—because it represents the difference in the brightness between the light and the dark portions of the picture—is accomplished via modulation of the peak-to-peak amplitude of the video signal. By modulating the peak amplitude of the video signal, the difference between the brightest portions of the picture and the darkest portions can be changed. That change is typically accomplished in CRT displays via a video amplifier, as shown in Figures 15-11A and 15-11B of Petitioner’s Fink reference:

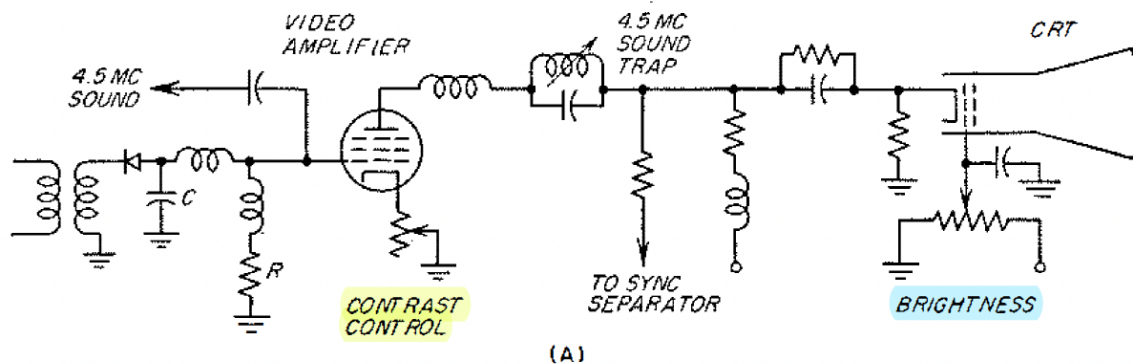


FIG. 15-11A. Single-stage video amplifier—d-c coupled.

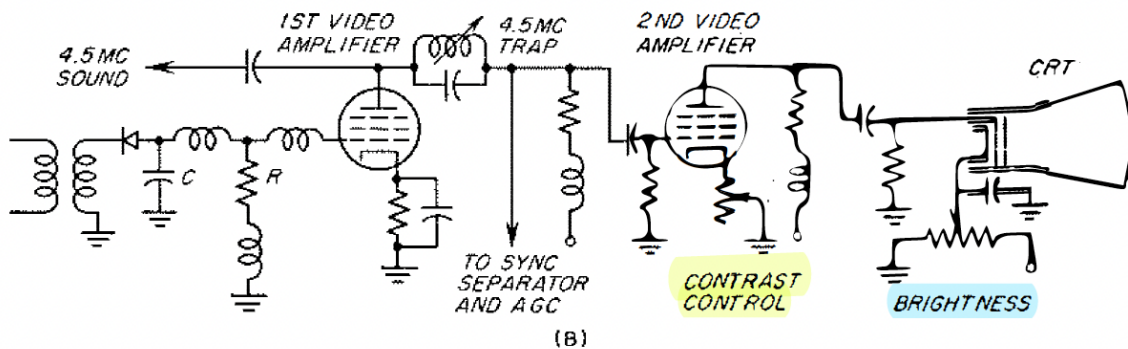


FIG. 15-11B. Two-stage video amplifier—a-c coupled.

EX2005, FIGs. 15-11A, 15-11B (annotated).

52. In the above figures, the Fink reference shows a video amplifier in the single-stage video amplifier for controlling the contrast, and a second video amplifier in the two-stage video amplifier for the same. Brightness, however, is separately labeled because brightness control is accomplished by adjusting the bias of the picture tube (another term for the cathode ray tube in a CRT display), which modulates the overall brightness of the picture. This disclosure is consistent with Grob, which summarizes contrast and brightness as shown below.

PICTURE QUALITIES		
QUALITY	PICTURE	SIGNAL
Contrast	Range between black and white	Amplitude of ac video signal
Brightness	Background illumination	DC bias on picture tube

EX2004, 40.

These settings are controlled via two entirely separate mechanisms and are not equivalent as Petitioner suggests.

53. Finally, I have reviewed the prosecution history of U.S. Patent No. 7,468,722, which is the parent of the '117 Patent. In the prosecution history, I note that the Examiner recognized the difference between brightness and contrast in regards to prior art during prosecution. Specifically, the Examiner noted that neither setting would affect the other:

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify Park and Sanchez to have selectively

adjust brightness of the image 20 having voltage signal 11, a PWM, and a ramp signal 14 as taught by Dupont, because this would adjust independently the contrast and brightness without one effecting the other (col. 4, lines 42-43 of Dupont).

EX2010, 10.

54. Petitioner also argues in the alternative that, to the extent Stoughton does not disclose a “user selectable brightness setting,” it would have been obvious to combine Stoughton with Mierzwinski to provide such a setting. Pet., 17. I disagree. First of all, Mierzwinski itself discloses no user adjustments. EX1004, 1:35-40, 1:62-67. In fact, Mierzwinski explains that user-adjustable settings are an aspect of the prior art that it intends to solve by providing a completely automatic system. *Id.*

55. The Petition does not contain any disclosure of how Stoughton and Mierzwinski would be combined to provide such a “user selectable brightness setting.” Coupled with Mierzwinski’s clear teaching away from manual controls, it is entirely unclear how—and why—a POSA would have been motivated to combine the two references, especially given that Mierzwinski has no manual brightness control. Thus, it is my opinion that Stoughton, Mierzwinski, and Nagai, either alone or in combination, cannot disclose or render obvious a “user signal”/“user input signal” indicative of a “user selectable brightness setting.”

B. Claim 1: “dark level bias” limitations

56. I understand that the Petition asserts that Stoughton alone or, alternatively, Stoughton in combination with Mierzwinski discloses “a dark level bias configured to adjust the combined signal to generate a brightness control signal that is used to control a brightness level of a visible display” as recited in claim 1 and “adjusting the combined signal with a dark level bias to generate a brightness control signal for controlling brightness of a visible display” of claim 15.

57. It is my opinion that neither Stoughton alone nor Stoughton in combination with Mierzwinski discloses “a dark level bias configured to adjust the combined signal to generate a brightness control signal”/“adjusting the combined signal with a dark level bias to generate a brightness control signal” for three reasons. First, Stoughton does not disclose both a “combined signal” and a “brightness control signal.” Second, in addition to the lack of separate signals, Stoughton does not disclose a “brightness control signal” at all. Finally, Petitioner’s proposed combination of Stoughton and Mierzwinski would not provide a “brightness control signal,” and a POSA would never have been motivated to combine the two references.

58. With respect to the disclosure of a “combined signal” and a “brightness control signal,” I understand that Petitioner identifies the voltage

across Stoughton's capacitor 33 is both the combined signal and the brightness control signal. Specifically, Petitioner claims as follows:

The *claimed “brightness control signal”* in Stoughton *corresponds to voltage VC . . .*

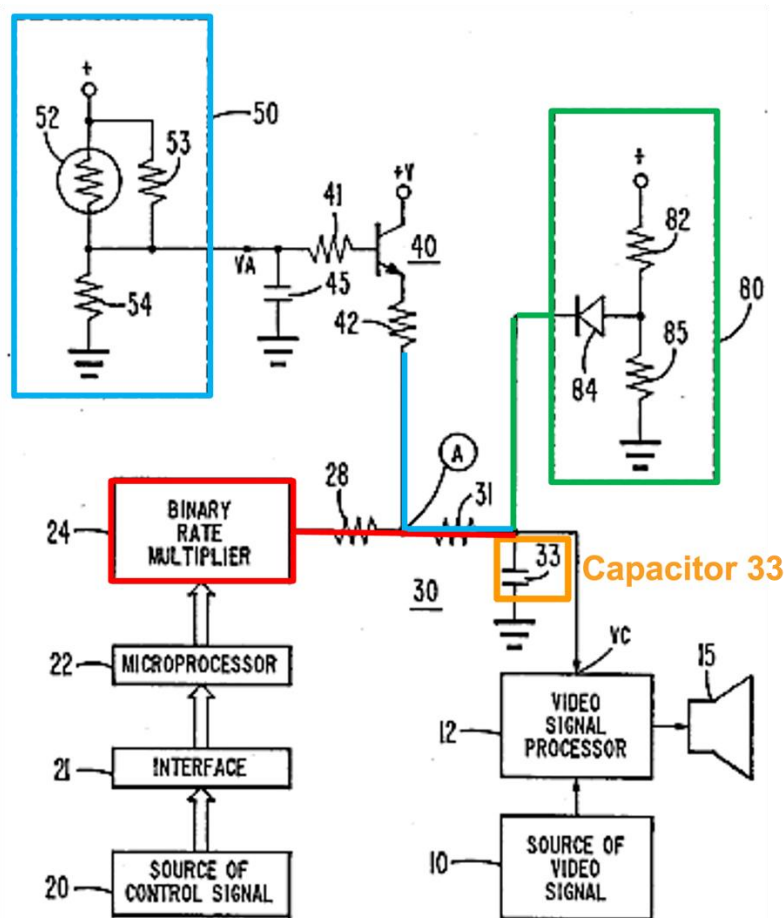
Accordingly, the output signal of Stoughton's limiter circuit 80 is “configured to adjust [i.e., increase] the *combined signal [i.e., the voltage VC across capacitor 33]* based on multiplying the output of BRM 24 and the pull-up voltage at the emitter of transistor 40] to generate a *brightness control signal [i.e., the adjusted voltage VC across capacitor 33]* . . .

The *“brightness control signal”* thus corresponds, as noted, to the *voltage VC across capacitor 33*, which is output to video signal processor 12 to control the display contrast.

Pet., 26, 31-32.

59. I am informed and understand that, generally, where claim elements are referred to by separate names, the assumption is that those claim elements are distinct structures. I also understand that the Patent Trial and Appeal Board previously held that “the ‘combined signal’ and ‘brightness control signal’ are different.” EX2013, 13. In my opinion, Petitioner's identification of voltage VC across capacitor 33 as both the combined signal and the brightness control signal is thus improper, because voltage VC does not have different values at different positions in the circuit. Rather, voltage VC across capacitor 33 is always the result

of the outputs of the BRM, the alleged light sensor, and the limiter circuit 80, as shown in below in the annotated Figure 1 of Stoughton.



EX1003, FIG. 1 (annotated).

60. It is important to note that the output of BRM 24 (in red), the output of transistor 40 from the alleged light sensor (in blue), and the output of limiter circuit 80 (in green) are all upstream of capacitor 33 across which voltage VC is found. Thus, it would not make any sense to consider the “combined signal” to be voltage VC across capacitor 33 *prior to* the limiter circuit 80, as there is no such

voltage. Voltage VC across capacitor 33, which is marked in orange above, is found in only one location and has only one value as a result of all three of these components. In short, voltage VC across capacitor 33 is a singular signal at any point in time, and cannot be separated out into stages or steps in order to comprise two separate signals. Thus, the Petition could at most be identifying either an alleged “combined signal” or an alleged “brightness control signal” as voltage VC across capacitor 33, but not both. Because of this, the Petition inherently fails to identify both signals in Stoughton. It is thus my opinion that Petitioner’s mapping of the elements to Stoughton does not disclose both a “combined signal” and a “brightness control signal,” meaning that there can also necessarily be no “dark level bias” that adjusts the former to produce the latter.

61. With respect to whether Stoughton discloses a “brightness control signal” at all, it is my opinion that Stoughton does not contain any such disclosure. As I explained in Section VII.A above, Stoughton fails to disclose any brightness controls at all. I explained at length in that section that, rather than brightness controls, Stoughton only discloses changes to contrast, a separate and entirely different concept. It is my opinion that Petitioner’s inaccurate conflation of contrast and brightness similarly means that Stoughton cannot disclose a “brightness control signal that is used to control a brightness level of a visible display” as recited in claim 1 and “a brightness control signal for controlling

brightness of a visible display” as recited in claim 15, because Stoughton does not control the brightness of a visible display at all, only its contrast. As I explained above, brightness is not controlled by a video signal’s amplitude, but rather is controlled by the DC bias of the picture tube. Because Stoughton does not disclose any circuitry that would affect the DC bias, and instead only discloses circuitry for modulating the amplitude of the video signal, it is my opinion that Stoughton cannot disclose a “brightness control signal.”

62. Finally, with respect to Petitioner’s alternative proposal under which Stoughton, in combination with Mierzwinski, would render obvious a “brightness control signal,” it is my opinion that this is incorrect and not supported by any disclosures in Mierzwinski. Petitioner states that “it would have been obvious based on Stoughton alone, or in view of Mierzwinski, that voltage VC qualifies as a ‘**brightness control signal that is used to control a brightness of a visible display.**’” Pet., 32 (emphasis in original).

63. However, the Petition does not cite to any disclosure supporting this theory of combination. While the Petition references Dr. Baker’s declaration, Dr. Baker’s opinion is simply that “it would have been obvious in light of Mierzwinski to modify the Stoughton circuit such that it controls both contrast and brightness of kinescope 15.” EX1002, ¶221. This explanation is lacking in any detail as to how this combination would be made, which is a critical flaw, given that Stoughton

discloses no circuitry capable of modifying the DC bias to the picture tube in order to control the brightness of the picture, rather than its contrast. Neither Petitioner nor Dr. Baker explain what modifications would be necessary to integrate these two systems. Neither explain why a POSA would have a reasonable expectation of success in attempting to utilize Stoughton's voltage VC, which is configured to modulate the video signal amplitude, to instead modify the picture tube bias. In my opinion, without significant and extensive modifications, there would be no way to utilize Stoughton's voltage VC to adjust the picture's brightness level. Stoughton's only disclosure is of using a user's manual contrast selection and ambient light information to control the contrast via modulation of the amplitude of the video signal. There is no disclosure of any such modifications in any of the Stoughton, Mierzwinski, or Nagai references in Ground 1 or 2 . In fact, while the Petition claims that Stoughton and Mierzwinski's circuits are similar, this is not the case. Pet., 14. Besides the fact that Stoughton is configured to receive and process user input, and Mierzwinski is intentionally not so configured, Stoughton contains mixed-signal circuits with both analog signals and digital signals, including software, a digital binary rate multiplier, a digital-to-analog converter, and an integrator. Mierzwinski (and, for that matter, Nagai) do not mention video signal processors like that used in Stoughton, and contains other components not present in Stoughton, such as LEDs. These types of components are not present in

Mierzwinski, which only discloses analog circuitry and does not perform any mathematical manipulation such as integration. *Compare* EX1004, FIG. 2; EX1003, 1:30-49, 2:48-67, 4:16-21, FIGs. 1-2.

64. Finally, I note that as I explained above in Section VII.A, a POSA would not have been motivated to combine Stoughton with Mierzwinski. Stoughton is a contrast-only control circuit with manual input, while Mierzwinski's chief aim is to escape the prior art's "manually operable controls." EX1004, 1:22-24. Mierzwinski repeatedly affirms its focus on automatic control. EX1004, 1:35-40 ("It is accordingly an object of the present invention to provide automatic color saturation control"), 1:62-67 ("By using the teaching of this invention, other gain relationships between the luminance components and chroma signal . . . may be automatically attained"), 5:34-36 ("automatic control circuit of the present invention"). In my opinion, a POSA would not have had any motivation to combine a reference that eschews all user input with Stoughton in order to add *more* user input, since such a combination would be in opposition to the fundamental concept of Mierzwinski.

65. For the reasons I have detailed above, it is my opinion that the combination of Grounds 1 and 2 does not disclose or render obvious the "dark level bias" limitations of claims 1 and 15.

VIII. GROUND 3

66. I have reviewed the Petition and the Declaration of Dr. Baker regarding Ground 3 of the Petition, as well as the Gettemy, Kerman, Rosenzweig, Whitted, and Bell references utilized in Ground 3. It is my opinion that the Petition's combination fails to disclose or render obvious claims 1-2, 7, 9, and 15-16 for the reasons explained below.

A. "a light sensor" and "sensing signal" of Claim 1 and "sense signal" of Claim 15

67. I understand that the Petition asserts that the combination of Gettemy, Kerman, Rosenzweig, Bell, and Whitted discloses a "light sensor" configured to output a "sens[e/ing] signal" in the form of Gettemy's light sensor 390 and software executed by main processor 310. Pet., 53. The Petition further asserts that the "sensing signal" is "a brightness range determined by main processor 310 based on the current ambient light level." *Id.*, 50.

68. It is my opinion that the Gettemy combination does not disclose a "light sensor" as claimed by Petitioner. Specifically, the Petition asserts that the light sensor includes "main processor 310" and its software. *Id.* It is my opinion that this is not a disclosure of a "light sensor" configured to output a "sens[e/ing] signal." As I explained above in Section VI.A, light sensors are a standard type of component that a POSA would have understood to comprise a light detector and,

in some cases, additional directly related components within the circuit of the light sensor, such as capacitors, amplifiers, or transistors. However, a POSA would not have considered a microprocessor and software to be a component of a light sensor at the time of the invention. I note that this understanding of a “light sensor” is shared by the inventor of Gettemy, as the “light sensor 390” in Gettemy, along with any of its internal circuitry, is contained within the functional block labeled “Light Sensor” in Gettemy’s Figure 3:

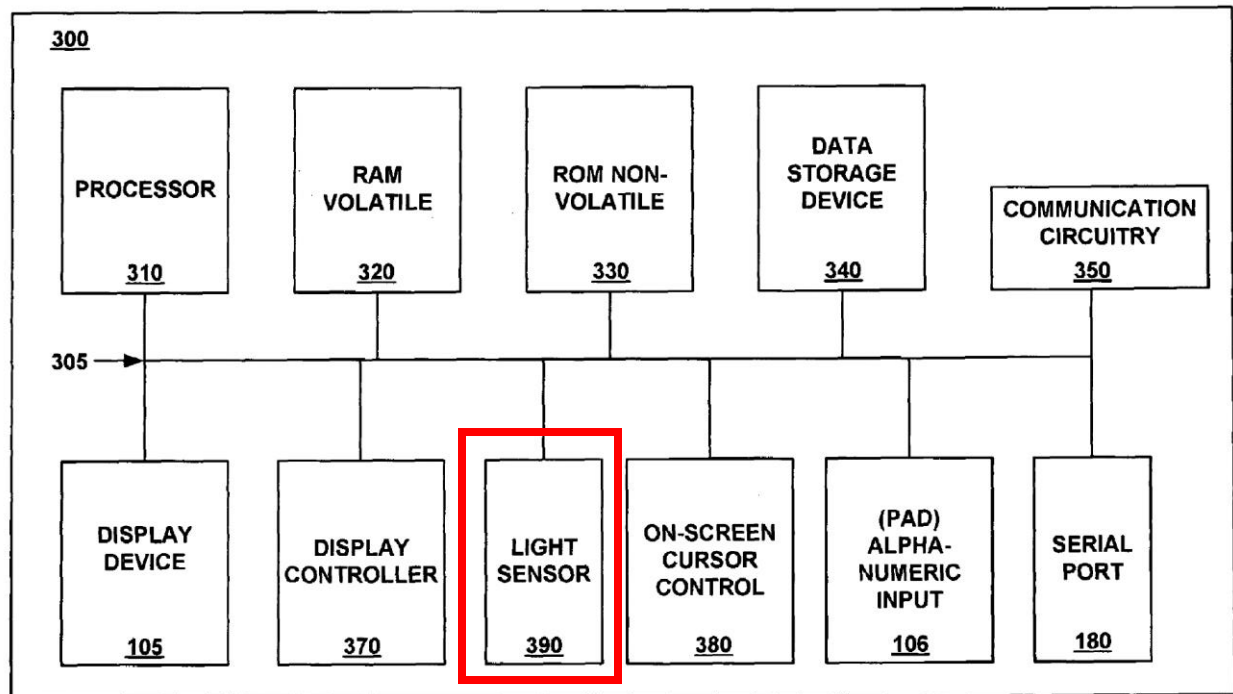


FIGURE 3

EX1013, FIG. 3 (annotated).

69. I am not aware of any light sensors at the time of the invention which included any microprocessors or software. After reviewing the transcript of Dr.

Baker's deposition, while he testified that he allegedly purchased a light sensor that included a microprocessor, I note that his testimony was that this first took place in "the late 2010s, before 2020." EX2032, 24:7-11. Thus, it remains my opinion that a POSA would not have considered a light sensor at the time of the invention to include components entirely outside of the light sensor and inside other functional circuits of the device, especially a microprocessor and software, which are separately-described components of the Gettemy invention contained in their own separate functional blocks. Rather, a POSA would have understood the "light sensor" of Gettemy to, at best, consist of "light sensor 390."

70. I understand that Petitioner further advances the theory that the "sens[e/ing] signal" of claims 1 and 15 is comprised by the "brightness range" in Gettemy. Pet., 50. It appears this theory was selected because, as the Petition admits, "Petitioner has not mapped the 'sensing signal' of claim 1[b] to a raw sensor signal provided by ambient light sensors 390, as this information is not directly used to determine display brightness." Pet., 52, EX1002 ¶286. It is my opinion that this mapping is not correct. The "sensing signal" identified by Petitioner is not actually output by the light sensor at all. Gettemy's light sensor 390 does, in fact, output a signal corresponding to the ambient light level. I note that Dr. Baker agrees with my opinion in this regard. During his deposition, Dr. Baker agreed that Gettemy's light sensor is actually what outputs an alleged

sensing signal that is used by main processor 390, rather than the Petition's claim that Gettemy's brightness range is the sensing signal. EX2032, 34:2-17.

71. In sum, it is my opinion that the Petition improperly maps the "light sensor" and "sens[e/ing] signal" claim elements to structures in Gettemy incorrectly, and it is my opinion that the Gettemy combination does not disclose either a "light sensor" or "sens[e/ing] signal" as mapped. The Petition's alleged "light sensor" includes a microprocessor and software, neither of which a POSA would understand to be part of a "light sensor." Furthermore, as the Petition and Dr. Baker admit, the "sensing signal" identified in the Petition is not actually output by the light sensor 390, the output of which is not actually used to set the brightness directly. Dr. Baker's agreement that the "sensing signal" is, at best, what is output directly by the light sensor confirms my opinion in this regard.

B. "selectively generate" of Claim 1 and "selectively multiplying" of Claim 15

72. The Petition and Dr. Baker's declaration appear to claim, without elaboration, that the Gettemy combination discloses and renders obvious the "selectively generate" and "selectively multiplying" portions of claims 1 and 15, respectively. Pet., 54-64; EX1002 ¶¶291-321. However, I note that neither the Petition nor Dr. Baker's declaration contain any analysis of how the "selectively generate" and "selectively multiplying" limitations are performed in the

combination or where the “selectively generate” and “selectively multiplying” limitations are taught in the prior art. It is my opinion that the Gettemy combination neither discloses nor renders obvious any of the “selectively” limitations. Because the Petition and Dr. Baker do not address the “selectively generate” and “selectively multiplying” limitations of claims 1 and 15, it is my opinion that neither the Petition nor Dr. Baker have shown that the Gettemy combination teaches or renders obvious “selectively generat[ing]” or “selectively multiplying” as recited in claims 1 and 15, respectively.

C. “dark level bias” of Claims 1 and 15

73. I understand that the Petition asserts both that the Gettemy combination discloses or renders obvious a “dark level bias,” and that a POSA would have been motivated to combine Bell and Whitted with Gettemy to provide this alleged “dark level bias.” Pet., 66-72. It is my opinion that neither of these claims are correct. I address each claim in turn below.

a. The Gettemy combination does not disclose or render obvious a “dark level bias”

74. I discuss in detail above in Sections V and VI.C the ’117 patent’s novel “dark level bias.” Namely, the “dark level bias,” rather than providing an absolute minimum or substituting or otherwise replacing the combined signal, instead provides a value used to mathematically adjust the combined signal in

order to maintain the brightness control signal above a predetermined minimum.

As a primary matter, I note that the Petition admits that the Gettemy reference itself does not disclose a “dark level bias.” Pet., 66. Instead, the Petition relies on the combination of Gettemy with, among others, Whitted and Bell to provide a supposed “dark level bias.”

75. There are several issues with the proposed combination’s supposed disclosure of a “dark level bias.” I note that Petitioner and Dr. Baker do not actually rely on a specific teaching found in Bell or Whitted, “rather, rel[ying] on them only for general teachings about maintaining a brightness level above a predetermined minimum threshold value.” Pet., 70. In doing so, Dr. Baker proposes a *de novo* modification to the software of Gettemy, in which the combined signal is **replaced**, rather than adjusted, when it falls below a threshold value.

76. Dr. Baker explains the specifics of his proposed modification in his declaration:

Under the proposed combination based on Gettemy, the software executed by main processor 310 would have been further adapted, before generating the brightness control signal that it sends to display controller 370 to change the current display brightness (Gettemy, 6:11-16, 5:37-39), to **check whether the display brightness value computed at claim 1[c] (“combined signal”) exceeds a**

predetermined minimum threshold level as disclosed in Whitted and Bell. For example, using an example from Gettemy above, suppose the user placed the slider at the ten percent (10%) position when the slider control was showing the “dark or dimly lit” range of Figure 5 between 5-65 nits. This would have resulted in the following display brightness value: $(0.1 \times 60) + 5 = 11$ (“combined signal”). Under the further combination with Whitted and Bell, the main processor in Gettemy would have further adapted, for example using elementary IF-THEN logic, to check whether 11 (“combined signal”) is greater than a desired minimum threshold value . . . That code uses simple **IF-THEN logic to check whether pValue (the value of the slider) is less than pMinimumValue, and if so, it sets the value of pValue to pMinimumValue.** (Rosensweig, pp.322-323 (“... **if pValue < pMinimumValue then pValue = pMinimumValue**”).) Applying that basic technique to implement the minimum threshold brightness teachings of Whitted and Bell would have predictably resulted in, “when the ambient light level decreases to approximately zero,” i.e., in dimly lit to entirely dark environments, as ambient luminance approaches and/or reaches approximately zero, the display brightness value in Gettemy being adjusted to ensure that the corresponding “brightness control signal” that is sent to display controller 370 is maintained above a predetermined level.

EX1002, ¶332.

77. Dr. Baker’s combination, in my opinion, does **not** disclose a “dark level bias.” As I explained above in Sections V and VI.C, a “dark level bias” is

more than a mere replacement or minimum signal that overwrites the combined signal if it is too low. The “dark level bias” of the ’117 patent is a specific value used to mathematically adjust the combined signal. As I also noted above in those sections, I understand that the USPTO made the same determination in the *ex parte* reexamination of the ’117 patent, correctly recognizing that a “dark level bias” could not be equivocated with “a threshold or minimum brightness level that overrides, substitutes for, or replaces the combined signal with another value.” EX2028, 4-5, 16, 17. However, what Dr. Baker proposes in his declaration is exactly that.

78. Looking to the “IF-THEN” logic described in Dr. Baker’s declaration, we see Dr. Baker’s explicit claim that, if “pValue (the value of the slider) is less than pMinimum Value . . . it sets the value of pValue to pMinimumValue,” overriding the alleged “combined signal” entirely with a new value. EX1002, ¶332. This is explicitly contrary to the teachings of the ’117 patent regarding the “dark level bias” I described above in Sections V and VI.C, and contrary to the USPTO’s findings confirming the same. Furthermore, it is important to note that replacing one signal with another is *not* a mathematical adjustment of the first signal. Rather, it is a wholesale replacement of the first signal, which no longer exists and has been discarded entirely in favor of the latter signal.

79. Because of this, it is my opinion that the proposed combination identified in the Petition and detailed by Dr. Baker does *not* demonstrate a “dark level bias.”

b. A POSA would not have been motivated to combine Gettemy with Bell and Whitted as proposed

80. There are several problems with the Petition’s proposed combination of Gettemy with Bell and Whitted in order to provide an alleged “dark level bias.” Chief among them, in my opinion, is that Gettemy *already* has a mechanism that ensures a predetermined level of brightness.

81. Importantly, none of the references cited in the Petition or by Dr. Baker discuss adding a second minimum brightness level. Whitted and Bell both disclose single minimum brightness levels. EX1017, 6:1-8; EX1016, 8:9-25. As discussed above, so too does Gettemy. While Petitioner and Dr. Baker claim to be relying on Bell and Whitted for general concepts, in my opinion, they appear to be creating the concept of a two-minimum system based on no teachings from the prior art.

82. As a practical matter, it makes no sense to create a second minimum that supersedes the first minimum. Adding a second minimum higher than the first minimum would cause multiple issues. A user would not be able to set the brightness to the first minimum presented, due to the second minimum, which

would make displaying that first minimum pointless and likely frustrating to a user. Conversely, if it were lower, it would never have any effect. In such a system with an existing minimum value, if a POSA believed that value to be insufficient, the rational choice would simply be to increase Gettemy's minimum value of 5 nits. Indeed, I understand that Dr. Baker testified to the same effect, saying he would not "argue that it isn't true" that "if the goal is simply to have a bright enough display and that's what the designers are going for, then yes, you could increase the minimum to have a bright enough display":

Q: We had touched on this earlier, but if 5 nits, as you say, might have been too dark or too dim, why wouldn't you just make the minimum higher than 5 nits?

. . .

A: **Well, I mean if – you could adjust the lower levels as a design choice in Gettemy alone**, but, you know, there's other concerns that I discussed that are brought up in the Whitted and Bell references on why you would adjust the display brightness the way you would. For example, using non-backlit displays and how the adjustment is done. It's just there are different design choices that one could make. And I'm not going to argue that that isn't true.

Q: So when you say you're not going to argue it's not true, you mean you're not going to argue that making the minimum higher wouldn't also accomplish this goal or . . .

...

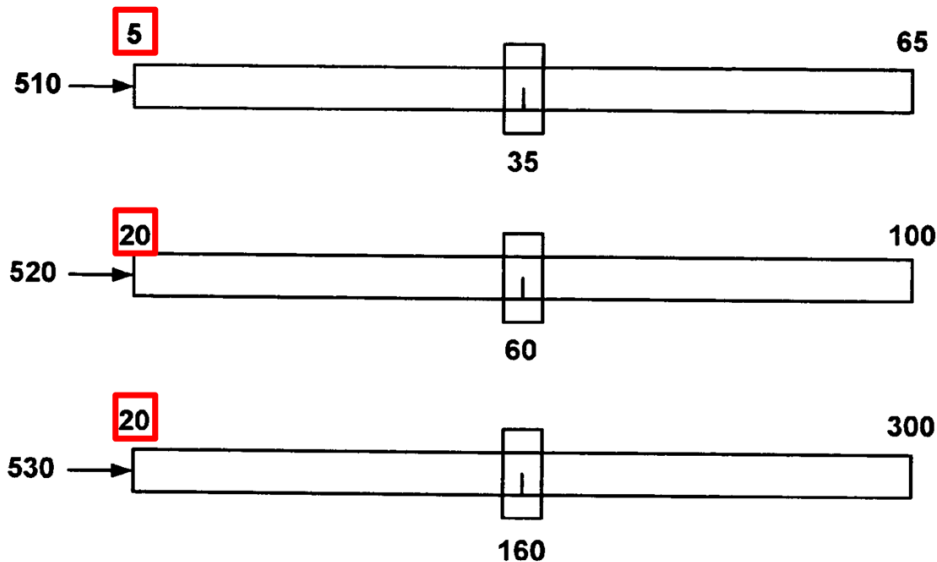
A: Well, I mean, when you say “this goal,” I’m not entirely sure what you mean. **If the goal is simply to have a bright enough display and that’s what the designers are going for, then yes, you could increase the minimum to have a bright enough display.** But we talked about how the user might want more adjustment at the lower end, and so there’s an asymptotic relationship. I briefly talked about displays aging and there being an adjustment to compensate for like the back light not being as bright.

...

EX2032, 65:11-66:20.

83. Indeed, maintaining a minimum brightness is already the aim of Gettemy’s brightness range minimum value. As Gettemy itself explains, the system is designed to present the user, depending on the amount of detected ambient light, with different slider bars to manually adjust the brightness, as shown in Figure 5 below:

Brightness Range Minimum Value



EX1013, FIG. 5 (annotated).

84. Each of the possible ranges for manual adjustment prominently features a brightness range minimum value, below which a user *cannot* decrease the display brightness. These values are consistently referred to in the claims of Gettemy as predetermined (i.e., stored in memory) minimums. See, e.g., EX1013, 2:41-44 (“the processor implements the adjustment for the range settings based on *prestored range configuration data*”), 5:60-63 (“*stored data which configures the ranges*”), claim 1 (“*stored ranges*, wherein each stored range . . . comprises a brightness range maximum value and a *brightness range minimum value*”), claim 10 (“*stored preconfigured dynamically adjustable brightness ranges*, wherein each stored range . . . comprises a brightness range maximum value and a *brightness range minimum value*”), claim 19 (“*each stored brightness range . . .*

comprises a brightness range maximum value and a ***brightness range minimum value***”).

85. To circumvent this reality of Gettemy, Dr. Baker opines in his declaration that “nothing in Gettemy” explicitly states that the “minimum value of the brightness range is to ensure that the final display brightness value used to control the brightness of the display meets a predetermined desired level of brightness.” EX1002, ¶34. But this is not logical. It is inarguably the case that these values were selected by the designers of the system as predetermined minimum brightness values for the display in each different range. That is, of course, how these values come to be stored in Gettemy’s memory. EX1013, 2:41-44, 5:60-63. These values provide a minimum brightness for the display, and a user *cannot* adjust the brightness below these values. I note that Dr. Baker actually agreed with this assertion during his deposition. EX2032, 44:8-20.

Q: In paragraph, I believe, 324 of your Declaration you state that:

‘The system in Gettemy will not permit the user to set the slider below the lower end of the displayed range. Correct?’

A: Yes.

Q: So the designers of the system don’t allow a user to set the brightness bar below 5 nits, correct?

...

A: Gettemy alone, as discussed in 324, limits the minimum to the 5, yes.

EX2032, 44:8-20 (discussing the brightness range 510, specifically).

86. In fact, despite claiming in his declaration that a POSA may not have found the minimums acceptable, Dr. Baker testified that he agreed that this minimum could be considered a predetermined level of brightness:

Q: So using range 510 as an example, you agree that 5 is the minimum value of that brightness range, right?

A: In Gettemy alone, yes.

Q: And it's your position that that's not necessarily a predetermined desired level of brightness, right?

A: 5 can be a predetermined level of – predetermined level, as I discussed in this section. It's just when you are moving the cursor, how you calculate what the actual display is doing, and you adjusting, and how you're setting this I guess is more what I'm discussing.

EX2032, 56:6-19.

87. Dr. Baker went on to testify that Gettemy's lower bound specifically ensures that the brightness doesn't fall below the minimum:

Q: And you agree that in that – what I believe Gettemy calls it the darker [sic] dimly lit embodiment brightness range 510, the lower bound makes sure that the screen brightness doesn't fall below 5 nits, correct?

...

A: Yes. I mean, I – as I showed in that example, if you were to move the slider to zero, then 5 would be the output, and that's to make sure

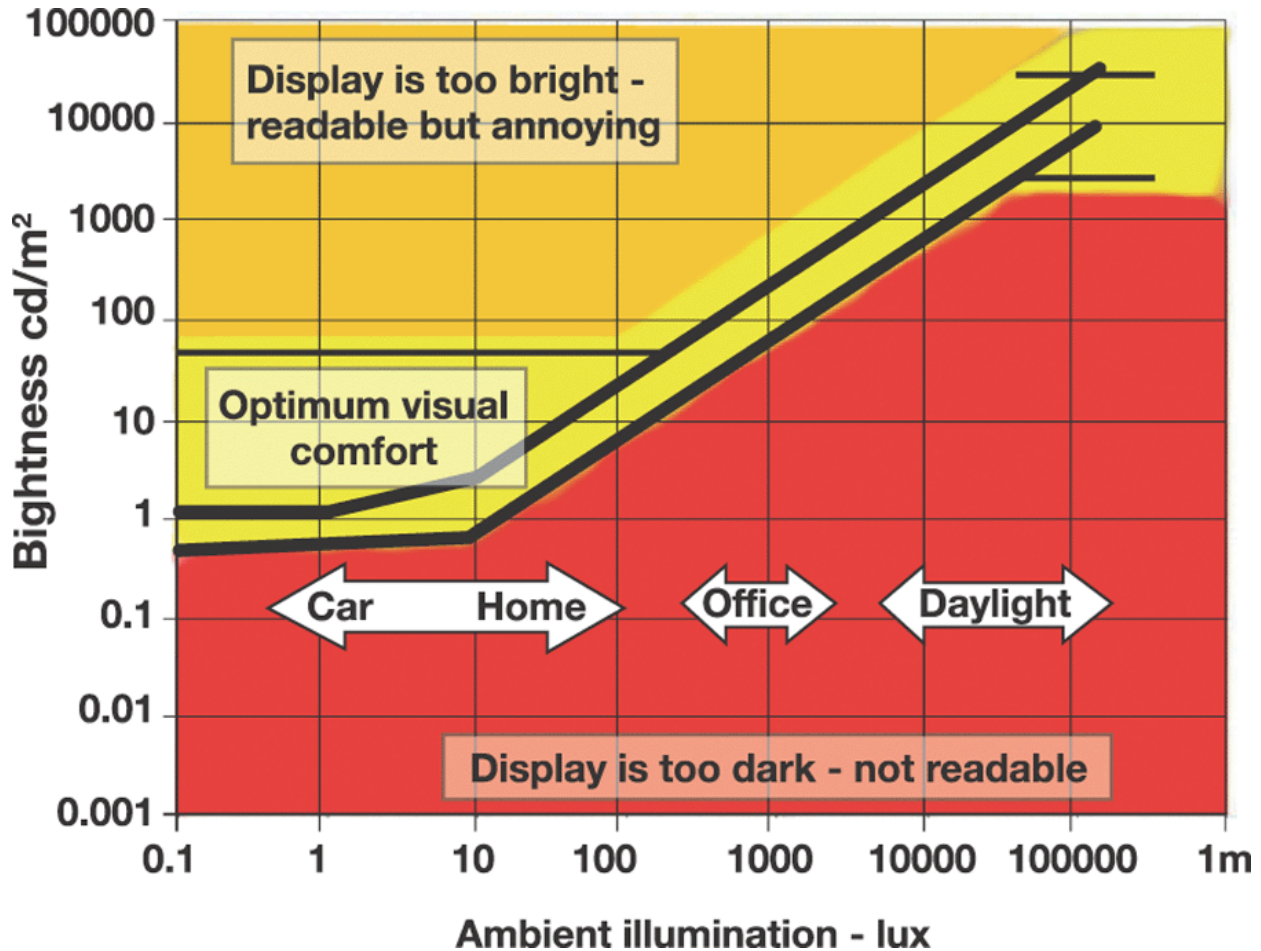
the brightness doesn't fall below the lower bound of range 5 to 65 in that particular example.

EX2032, 57:10-21.

88. It is thus my opinion—and it appears to be Dr. Baker's opinion as well—that Gettemy has a clearly established mechanism for preventing the brightness of the display does not fall below a predetermined level. However, as I explained above, Petitioner and Dr. Baker acknowledge that mechanism is not a “dark level bias.” Thus, it is my opinion that there is no motivation for a POSA to look to additional references in order to add a functionality already contemplated by—and implemented by—the Gettemy reference.

89. Furthermore, Gettemy already ensures a comfortable level of minimum brightness without the need for any additional systems. As stated in Gettemy and, as confirmed by Dr. Baker above, Gettemy limits the screen brightness to 5 nits in the discussed embodiment. EX1013, FIG. 5. 5 nits is a completely acceptable level of brightness for a display in Gettemy's “dark or dimly lit” conditions, which would correspond to situations where “the ambient light level decreases to approximately zero” as recited in claim 1. As shown in a figure published in an article in the EE Times, “Optimum visual comfort” is achieved in ambient illumination levels from roughly 0.1 lux (approximately total darkness) to 10 lux (identified as part of the range corresponding to the interior of a car or

home) by brightness levels between 1 to 5 nits on the upper line and roughly .7 to .8 nits on the lower line (candela per meter squared):



EX2033, 3; *see also* EX2034, 2.

90. There is no reason why a POSA would find 5 nits to be an unreasonably low level of screen brightness, particularly given that it is already 5 times higher than the upper line for “optimum visual comfort” at approximately 0 lux of ambient brightness. In fact, I reviewed Petitioner’s exhibits and found that EX1020 appears to support my opinion, stating that its “nighttime mode” ranges

from “0.5 to 200 nits”, giving a minimum *one-tenth* of Gettemy’s. EX1020, ¶31. Gettemy itself confirms that the aim of these ranges is to improve and maximize the “readability” of the display. EX1013, Abstract, 1:10-15, 2:29-34. It makes little sense that Gettemy and EX1020 would both propose minimum brightnesses that are unreadable. While EX1020 and the EE Times article appear to disagree on the lower bounds of visual comfort, it is certainly the case that 5 nits is more than sufficiently readable in approximately zero ambient light. It is thus my opinion that this is further reason that a POSA would not have been motivated to add Bell and Whitted to Gettemy in order to provide an alleged “dark level bias,” as it would add nothing more than redundancy and unneeded complication.

91. Finally, I understand that Petitioner and Dr. Baker claim that the combination of Gettemy with Bell and Whitted to add a second minimum brightness would have been obvious in order to combat degradation in the display due to age. Pet., 71-72.; EX1002, ¶336. I disagree, and there are a number of problems with this theory. First, and foremost, Dr. Baker references EX1019 to allege that an LCD’s brightness degrades approximately 50% over its lifetime due to degradation of cold cathode fluorescent tubes (also called CCFTs, or CCFLs). EX1002, ¶336; EX1019, 1:53-2:37. However, Gettemy does not use CCFTs in its display system, and does not mention CCFTs or CCFLs or, for that matter, any type of fluorescent backlighting. EX1013, 1:61-65. So, at the outset, this fact

would not be relevant to a POSA examining Gettemy, which instead discloses using LEDs or other types of lighting. *Id.* Second, LED-backlit displays like those used by Gettemy had a lifetime of roughly 50,000 hours without significant degradation circa 2004. *See*, for example, EX2035, 1:45-52. Even CCFLs used by EX1019 had a lifetime of approximately 10,000-15,000 hours without significant degradation. *Id.* Doing simple math, this means that Gettemy, if using CCFLs and if operated 25 hours a week, would last roughly 7.7 years before significant display brightness degradation set in. If using LEDs, this lifetime would increase to roughly 38.5 years. Given the shorter service lifetimes of handheld computers, such as PDAs, at the time of the invention, a POSA would hardly have been motivated to address concerns about display brightness nearly eight years after a user began using a device, at which time the user likely would have replaced, upgraded, or otherwise discontinued use of the device. I note that Gettemy also describes transflective and reflective displays, display types that only typically utilize the backlight in dim lighting conditions. EX1013, 1:46-55; EX2036, 1:14-18. The lifetime of those types of displays would have been even longer, given that the backlight is not even used in higher ambient brightness conditions. Using a backlight more often will lead to faster degradation of the backlight. Therefore, using the backlight much less often, as is the case with reflective and transflective displays, the backlight will take much longer to degrade.

92. Most importantly, the Burke reference on which Dr. Baker relies for this idea does not support the Petition's proposed solution of an adjustment to the user-selectable screen brightness. In fact, Burke suggests the opposite: specifically, Burke says that "The controller 500 then monitors the bulb brightness through brightness sensors 506 and adjusts bulb current to maintain the brightness **at the user-defined level.**" EX1020, ¶[0032]. That is, Burke intelligently solves the problem in a way I agree would be most obvious to a POSA at the time, by making sure the backlight, if degraded, actually delivers the selected brightness, rather than artificially preventing a user from selecting a setting displayed to them.

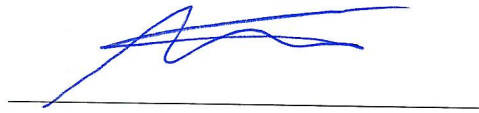
93. In sum, because Gettemy already has a mechanism by which minimum display brightness is enforced, the problems the combination purports to solve are inaccurate, and the mechanism proposed in the combination would not have at all been obvious to a POSA, it is my opinion that a POSA at the time of the invention would not at all have been motivated to combine Gettemy with Bell and Whitted, let alone in the manner described by Petitioner and Dr. Baker.

IX. ADDITIONAL REMARKS

94. This declaration reflects my opinions as currently held. However, my analysis may continue such that I may consider additional information that may result in additional observations.

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

Executed on this 6th day of February, 2024, in Buchanan,
Michigan.



Dr. Robert L. Stevenson

Appendix

Robert Louis Stevenson

Curriculum Vitae

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Professional Experience

10/2013–Present	Associate Chair, Director of Undergraduate Studies Department of Electrical Engineering University of Notre Dame, Notre Dame, Indiana
08/2002–Present	Professor Department of Electrical Engineering University of Notre Dame, Notre Dame, Indiana
01/2003–6/2017	Professor Department of Computer Science and Engineering University of Notre Dame, Notre Dame, Indiana
08/1996–08/2002	Associate Professor Department of Electrical Engineering University of Notre Dame, Notre Dame, Indiana
08/1996–06/1997	Visiting Associate Professor Department of Electrical and Computer Engineering University of Delaware, Newark, Delaware
06/1994–08/1994	Research Associate Intel Corporation, Hillsboro, Oregon
05/1993–08/1993	Research Associate Air Force Office of Scientific Research Rome Laboratories, Griffiss AFB, Rome, New York

08/1990–08/1996 Assistant Professor
 Department of Electrical Engineering
 University of Notre Dame, Notre Dame, Indiana

08/1989–08/1990 Graduate Research Assistant
 School of Electrical Engineering
 Purdue University, West Lafayette, Indiana

08/1986–08/1990 Graduate Teaching Assistant
 School of Electrical Engineering
 Purdue University, West Lafayette, Indiana

06/1986–08/1986 Intern
 Engineering Physics Laboratory, E. I. duPont
 de Nemours & Company, Wilmington, Delaware

06/1985–08/1985 Intern
 Corporate Technology Center
 Sperry Corporation, Reston, Virginia

Education

08/1986–08/1990 *Ph.D., Electrical Engineering*, August 1990
 Purdue University, West Lafayette, Indiana
 Thesis: *Invariant Reconstruction of Curves and Surfaces with Discontinuities with Applications in Computer Vision*
 Advisor: Professor Edward J. Delp
 GPA: 6.0/6.0

09/1982–06/1986 *B.S.E.E., Electrical Engineering*, June 1986
 University of Delaware, Newark, Delaware
 Thesis: *On the Theoretical Properties of Morphological Filters*
 Advisor: Professor Gonzalo R. Arce
 GPA: 4.0/4.0

Honors and Awards

1983 University of Delaware, Tau Beta Pi Prize

1984 University of Delaware, Engineering Scholar

1985–1986 University of Delaware, Liston A. Houston Scholarship

1986 IEEE Delaware Bay Section Engineering Award

1986	Valedictorian, University of Delaware
1986	Purdue University Graduate Instructor Fellowship
1986	Phi Kappa Phi Graduate Fellowship
1986–1990	DuPont Graduate Fellowship in Electrical Engineering
1986–1989	National Science Foundation Graduate Fellowship
1993	Dept. of Electrical Engineering Outstanding Teacher Award
2012	ICIP 2012 Outstanding Reviewer
2013	IS&T 2013 Service Award

Honor Societies

1985–Present	Eta Kappa Nu, Electrical Engineering Honor Society
1985–Present	Tau Beta Pi, Engineering Honor Society
1985–Present	Phi Kappa Phi, Academic Honor Society

Professional Activities

Associate Editor

IEEE Trans. on Image Processing, 1999–2003

IEEE Trans. on Circuits and Systems for Video Tech., 1997–2002

Journal of Electronic Imaging, 1995–1998

Special Issue Editor

Multimedia Systems, *Journal of Electronic Imaging*, 04/1996

Still Image Compression, *Electronic Imaging Newsletter*, 01/1996

Best Paper Award Board Membership

IEEE Trans. on Circuits and Systems for Video Technology, 2002

Symposium Chairman

SPIE/IS&T Symposium on Electronic Imaging, 02/2004

Conference Chairman

IS&T Conf. Computational Imaging XXI, 01/2023

IS&T Conf. Computational Imaging XX, 01/2022

IS&T Conf. Computational Imaging XIX, 01/2021

IS&T Conf. Computational Imaging XVIII, 01/2020

IS&T Conf. Computational Imaging XVII, 01/2019

IS&T Conf. Computational Imaging XVI, 02/2018

IS&T Conf. Computational Imaging XV, 02/2017

IS&T Conf. on Visual Information Proc. & Comm. VIII, 02/2017
 IS&T Conf. on Visual Information Proc. & Comm. VII, 02/2016
 SPIE/IS&T Conf. on Visual Information Proc. & Comm. VI, 02/2015
 SPIE/IS&T Conf. on Visual Information Proc. & Comm. V, 02/2014
 SPIE/IS&T Conf. on Visual Information Proc. & Comm. IV, 02/2013
 SPIE/IS&T Conf. on Visual Information Proc. & Comm. III, 01/2012
 SPIE/IS&T Conf. on Visual Information Proc. & Comm. II, 01/2011
 SPIE/IS&T Conf. on Visual Comm. and Image Processing, 01/2009
 SPIE/IS&T Conf. on Computational Imaging, 02/2003
 SPIE/IS&T Conf. on Image and Video Comm. and Proc., 02/2000
 SPIE/IS&T Conf. on Visual Comm. and Image Processing, 02/1999
 41st Midwest Symposium on Circuits and Systems, 08/1998
 SPIE Conf. on Electronic Imaging and Signal Processing, 11/1996
 SPIE/IS&T Conf. on Still Image Compression II, 02/1996
 SPIE/IS&T Conf. on Image and Video Processing IV, 02/1996
 SPIE/IS&T Conf. on Image and Video Processing III, 02/1995
 SPIE/IS&T Conf. on Image and Video Processing II, 02/1994

Steering Committee Member

Visual Communications and Image Processing, 1998–2010
 Midwest Symposium on Circuits and Systems, 1994–1999
 Electronic Imaging, 2003–2005

Organizing Committee Member

Nonlinear Signal and Image Processing Workshop, 2001

Technical Program Committee

International Conference on Image Processing, 1998 – Present
 SPIE Computational Imaging, 2003–2016
 Visual Communications and Image Processing, 1997–2008
 European Signal Processing Conference, 2015
 IEEE Symposium on Industrial Electronics & Applications, 2012
 International Conference on Multimedia & Expo, 2009–2010
 Image and Video Communications and Processing III, 2005
 Computational Imaging, 2004
 International Conference on Pattern Recognition, 2000
 Int. Conf. on Acoustics, Speech, & Signal Proc., 2000, 2006–Present
 International Symposium on Circuits and Systems, 1998, 2005
 9th IEEE Image and Multi. Signal Processing Workshop, 1996
 Midwest Symposium on Circuits and Systems, 1994

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Institute of Electrical and Electronics Engineers, IEEE

Society of Photographic Instrumentation Engineers, SPIE
The Society for Imaging Science and Technology, IS&T

Panel Member for the following funding agencies
National Science Foundation

Reviewer for the following funding agencies
National Science Foundation
U.S. Army Research Office
Israel Science Foundation
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North Dakota EPSCoR Program
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Reviewer for the following archival journals
IEEE Transactions on Signal Processing
IEEE Transactions on Image Processing
IEEE Transactions on Circuits and Systems
IEEE Transactions on Circuits and Systems for Video Technology
IEEE Transactions on Instrumentation and Measurement
IEEE Transactions on Medical Imaging
IEEE Transactions on Pattern Analysis and Machine Intelligence
IEEE Transactions on Systems, Man, and Cybernetics
IEEE Transactions on Neural Networks
Pattern Recognition Letters
Signal Processing Letters
Computer Vision, Graphics, and Image Processing
Journal of the Optical Society of America
Journal of Mathematical Imaging and Vision
Applied Optics
IET Image Processing

Reviewer for the following textbook companies
Van Nostrand Reinhold, Electrical Engineering Division
McGraw-Hill, College/Schaum Division
MacMillan Publishing Company
Prentice Hall

Publications

Journals

R. L. Stevenson and G. R. Arce, “Binary Display of Hexagonally

Sampled Continuous-Tone Images,” *Journal of the Optical Society of America A*, Vol. 2, pp. 1009–1013, July 1985.

G. R. Arce and **R. L. Stevenson**, “On the Synthesis of Median Filter Systems,” *IEEE Transactions on Circuits and Systems*, Vol. CAS-34, No. 4, pp. 420–429, April 1987.

R. L. Stevenson and G. R. Arce, “Morphological Filters: Statistics and Further Syntactic Properties,” *IEEE Transactions on Circuits and Systems*, Vol. CAS-34, No. 11, pp. 1292–1305, November 1987.

R. L. Stevenson and E. J. Delp, “Invariant Recovery of Curves in M-Dimensional Space from Sparse Data,” *Journal of the Optical Society of America A*, Vol. 7, No. 3, pp. 480–490, March 1990.

R. L. Stevenson and E. J. Delp, “Viewpoint Invariant Recovery of Visual Surfaces from Sparse Data,” *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Vol. 14, No. 9, pp. 897–909, September 1992.

R. L. Stevenson and S. M. Schweizer, “A Nonlinear Filtering Structure for Image Smoothing in Mixed Noise Environments,” *Journal of Mathematical Imaging and Vision*, Vol. 2, No. 2/3, pp. 137–154, November 1992.

R. L. Stevenson, G. B. Adams, L. H. Jamieson and E. J. Delp, “Parallel Implementation for Iterative Image Restoration Algorithms on a Parallel DSP Machine,” *Journal of VLSI Signal Processing*, Vol. 5, No. 2/3, pp. 261–272, April 1993.

R. L. Stevenson, B. E. Schmitz, and E. J. Delp, “Discontinuity Preserving Regularization of Inverse Visual Problems,” *IEEE Transactions on Systems, Man and Cybernetics*, Vol. 24, No. 3, pp. 455–469, March 1994.

R. R. Schultz and **R. L. Stevenson**, “Improved Definition Image Expansion,” *IEEE Transactions on Image Processing*, Vol. 3, No. 3, pp. 233–242, May 1994.

T. P. O’Rourke and **R. L. Stevenson**, “Human Visual System Based Wavelet Decomposition for Image Compression,” *Journal of Visual Communications and Representation*, Vol. 6, No. 2, pp. 109–121, June

1995.

R. R. Schultz and **R. L. Stevenson**, “Stochastic Modeling and Estimation of Multispectral Image Data,” *IEEE Transactions on Image Processing*, Vol. 4, No. 8, pp. 1109–1119, August 1995.

B. E. Schmitz and **R. L. Stevenson**, “Color Palette Restoration,” *CVGIP: Graphical Models and Image Processing*, Vol. 57, No. 5, pp. 409–419, September 1995.

S. Choi, R. R. Schultz, **R. L. Stevenson**, Y. Huang, and R. Liu, “Contrast Enhancement of Missile Video Sequence via Image Stabilization and Product Correlation,” *Optical Engineering*, Vol. 35, No. 12, pp. 3495–3507, December 1995.

T. P. O’Rourke and **R. L. Stevenson**, “Improved Image Decompression for Reduced Transform Coding Artifacts,” *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 5, No. 6, pp. 490–499, December 1995.

R. R. Schultz and **R. L. Stevenson**, “Extraction of High-Resolution Frames from Video Sequences,” *IEEE Transactions on Image Processing*, special issue on Nonlinear Image Processing, Vol. 5, No. 6, pp. 996–1011, June 1996.

R. L. Stevenson, “Inverse Halftoning via MAP Estimation,” *IEEE Transactions on Image Processing*, Vol. 6, No. 4, pp. 574–583, April 1997.

B. E. Schmitz and **R. L. Stevenson**, “Enhancement of Sub-Sampled Color Image Data,” *IEEE Transactions on Image Processing*, special issue on Color Image Processing, Vol. 6, No. 7, pp. 1052–1056, July 1997.

R. R. Schultz, L. Meng, and **R. L. Stevenson**, “Subpixel Motion Estimation for Super-Resolution Image Sequence Enhancement,” *Journal of Visual Communication and Image Representation*, special issue on High-Fidelity Media Processing, Vol. 9, No. 1, pp. 38–50, March 1998.

R. Lladós-Bernaus and **R. L. Stevenson**, “Fixed Length Entropy Coding for Robust Video Compression,” *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 8, No. 6, pp. 745–755, October

1998.

R. Lladós-Bernaus and **R. L. Stevenson**, “Edge Assisted Upper Band Coding Techniques”, *International Journal of Imaging Systems and Technology*, Vol. 10, pp. 67–75, January 1999.

Z. Peng, Y.-F. Huang, D. J. Costello, Jr., and **R. L. Stevenson**, “A Pyramidal Image Coder Using Generalized Rank-Ordered Prediction Filter”, *IEEE Transactions on Circuits & Systems for Video Technology*, Vol. 9, No. 4, pp. 540–544, June 1999.

M. A. Robertson and **R. L. Stevenson**, “Reduced-Complexity Iterative Post-Filtering of Video,” *IEEE Transactions on Circuits and Systems for Video Technology* Vol. 11, No. 10, pp. 1121–1128, October 2001.

M. A. Robertson and **R. L. Stevenson**, “Temporal Resolution Enhancement in Compressed Video Sequences,” *EURASIP Journal on Applied Signal Processing*, Special Issue on Nonlinear Signal Processing, pp. 230–238, December 2001.

B. E. Marino and **R. L. Stevenson**, “Improving the Performance of Single Chip Image Capture Devices,” *Journal of Electronic Imaging*, Vol. 12, No. 2, pp. 209–218, April 2003.

M. A. Robertson, S. Borman, and **R. L. Stevenson**, “Estimation-Theoretic Approach to Dynamic Range Improvement Through Multiple Exposures,” *Journal of Electronic Imaging* Vol. 12, No. 2, pp. 219–228, April 2003.

R. Magill, C. E. Rohrs, and **R. L. Stevenson**, “Output-Queued Switch Emulation by Fabrics with Limited Memory,” *IEEE Journal on Selected Areas in Communications*, Special Issue on High-Performance Electronic Switches/Routers for High-Speed Internet, Vol. 21, No. 4., pp. 606–615, May 2003.

M. A. Robertson and **R. L. Stevenson**, “DCT Quantization Noise in Compressed Images,” *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 15, No. 1, pp. 27–38, January 2005.

J. Gai and **R. L. Stevenson**, “Studentized Dynamical System for Robust Object Tracking,” *IEEE Transactions on Image Processing*,

Vol. 20, No. 1, pp. 186-199, January, 2011.

J. Gai and **R. L. Stevenson**, “Robust Contour Tracking Based On A Coupling Between Geodesic Active Contours and Conditional Random Fields,” *Journal of Visual Communications and Image Representations*, Vol. 22, No. 1, pp. 22-47, January 2011.

J. Simpkins and **R. L. Stevenson**, “A Parameterized Spatially-Varying PSF Model,” *Journal of Electronic Imaging*, Vol. 23, No. 1, January, 2014.

Y. Li, and **R. L. Stevenson**, “Incorporating Global Information in Feature-Based Multimodal Image Registration,” *Journal of Electronic Imaging*, Vol. 23, No. 2, March-April 2014.

Y. Li, and **R. L. Stevenson**, “A Similarity Metric for Matching Incomplete Edge Curves,” *International Journal of Machine Intelligence and Sensory Signal Processing*, Vol. 1, No. 2, pp. 153-173, 2014.

L. Hollmann and **R. L. Stevenson**, “Pole-Zero Placement Algorithm for the Design of Digital Filters with Fractional-Order Rolloff,” *Signal Processing* special issue on fractional signal processing and applications, Vol. 107, pp. 218-229, February 2015.

R. Zhen, and **R. L. Stevenson**, “Multi-Image Motion Deblurring Aided By Inertial Sensors,” *Journal of Electronic Imaging*, Vol. 25, No. 1, February 2016 .

Y. Li, and **R. L. Stevenson**, “Multimodal Image Registration With Line Segments By Selective Search,” *IEEE Transactions on Cybernetics*, Vol. PP, No. 99, April 2016.

L. Hollmann and **R. L. Stevenson**, “Adaptive whitening of ambient ocean noise with narrowband signal preservation” *Journal of the Acoustical Society of America*, Vol. 129, No. 6, pp. 3122, 3133, June, 2016.

R. Zhen and **R. L. Stevenson**, “Inertial Sensor Aided Multi-Image Nonuniform Motion Blur Removal Based on Motion Decomposition,” *Journal of Electronic Imaging*, Vol. 27, No. 5, October, 2018.

Y. Li, L. Wang, **R. L. Stevenson**, L. Wei, and R. Fan, “Reliable

Line Segment Matching for Multispectral Images Guided by Intersection Matches,” *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 29, No. 10, October 2019

M. R. Izadi, **R. L. Stevenson**, and L. N. Kloepper “Separation of Overlapping Sources in Bioacoustic Mixtures,” *Journal of the Acoustical Society of America*, Vol. 147, No. 3, March 2020.

S. Zhang, A. Zhen, and **R. L. Stevenson**, “Deep Motion Blur Removal Using Noisy/Blurry Image Pairs,” *Journal of Electronic Imaging*, Vol. 30, No. 3, 2021.

K. Kniazev, I. Pavlovets, S. Zhang, J. Kim, **R. Stevenson**, K. Doudrick, M. Kuno, “Using Infrared Photothermal Heterodyne Imaging to Characterize Micro- and Nano-Plastics in Complex Environmental Matrices,” *Environmental Science & Technology*, Vol. 55, No. 23, November 2021.

S. Zhang, K. Kniazev, I. Pavlovets, S. Zhang, **R. Stevenson**, Masaru Kuno, “Deep Image Restoration for Infrared Photothermal Heterodyne Imaging,” *The Journal of Chemical Physics*, Vol. 155, No. 21, December 2021.

S. Zhang, A. Zhen, and **R. L. Stevenson**, “DeblurExpandNet: Image Motion Deblurring Network Aided by Inertial Sensor Data,” *Signal and Image Processing*, January, 2022 (<https://doi.org/10.1007/s11760-021-02067-1>).

Journals Articles Reprinted in Books

R. L. Stevenson and G. R. Arce, “Binary Display of Hexagonally Sampled Continuous-Tone Images,” originally appeared as *Journal of the Optical Society of America A*, Vol. 2, pp. 1009–1013, July 1985, reprinted in *Selected Papers on Digital Halftoning*, SPIE Milestone Series, Vol. MS 154, J. Allebach, Ed., 1999.

Book Chapters

R. L. Stevenson and E. J. Delp, “Investigation into Building an Invariant Surface Model from Sparse Data,” in *NATO ASI: Active Perception and Robot Vision*, A. Sood and H. Wechsler, Eds., Springer

Verlag, pp. 539–558, 1992.

R. L. Stevenson and E. J. Delp, “Three-Dimensional Surface Reconstruction: Theory and Implementation,” in *3D Object Recognition Systems*, A. K. Jain and P. J. Flynn, Eds., Elsevier, pp. 89–114, 1993.

D. L. Cohn and **R. L. Stevenson**, “Using Redundancy to Speed up Disk Arrays,” in *Communications and Cryptography: Two Sides of One Tapestry*, R. E. Blahut, D. J. Costello, Jr., U. Maurer and T. Mittelholzer, Eds., Kluwer Academic Publishers, pp. 59–68, 1994.

R. Lladós-Bernaus, M. Robertson and **R. L. Stevenson**, “A Stochastic technique for the removal of artifacts in compressed images and video”, in *Signal Recovery Techniques for Image and Video Compression and Transmission*, A. K. Katsaggelos and N. P. Galatsanos, Eds., Kluwer Academic Publishers, 1998.

S. Borman and **R. L. Stevenson**, “Image Sequence Processing,” in *Dekker Encyclopedia of Optical Engineering*, R. B. Johnson, C. Hoffman, and R. G. Driggers, Eds., Marcel Dekker, Inc., 2003.

R. Schultz and **R. L. Stevenson**, “Bayesian Image and Video Enhancement Using a Non-Gaussian Prior,” in *Nonlinear Signal and Image Processing: Theory, Methods, and Applications*, K. Barner and G. Arce, Eds., CRC Press, 2003.

J. Simpkins and **R. L. Stevenson**, “An Introduction to Super-Resolution Imaging,” in *Mathematical Optics: Classical, Quantum, and Imaging Methods*, V. Lakshminarayanan, Ed., Taylor & Francis Books, Inc., 2012.

J. Simpkins, **R. L. Stevenson**, and S. Borman, “Image Sequence Processing,” in *Encyclopedia of Optical Engineering*, R. G. Driggers and C. Hoffman, Eds., Taylor & Francis., 2015.

R. Zhen and **R. L. Stevenson**, “Image Demosaicing,” *Color Image and Video Enhancement*, pp. 13–54, Springer, 2015.

Edited Conference Proceedings

S. A. Rajala and **R. L. Stevenson**, Eds., *Image and Video Processing II*, SPIE Proceedings Series, 1994.

R. L. Stevenson and S. A. Rajala, Eds., *Image and Video Processing III*, SPIE Proceedings Series, 1995.

R. L. Stevenson and M. I. Sezan, Eds., *Image and Video Processing IV*, SPIE Proceedings Series, 1996.

R. L. Stevenson, A. Drukarev, and T. R. Gardos, Eds., *Still Image Compression II*, SPIE Proceedings Series, 1996.

C.-S. Li, **R. L. Stevenson**, and L. Zhou, Eds., *Electronic Imaging and Multimedia Systems*, SPIE Proceedings Series, 1996.

R. L. Stevenson, Ed., *Proceeding of the Midwest Symposium on Circuits and Systems*, 1998.

K. Aizawa, **R. L. Stevenson**, and Y.-Q. Zhang, Eds., *Visual Communications and Image Processing '99*, SPIE Proceedings Series, 1999.

B. Vasudev, T. R. Hsing, A. G. Tescher, and **R. L. Stevenson**, Eds., *Image and Video Communications and Processing 2000*, SPIE Proceedings Series, 2000.

C. Bouman and **R. L. Stevenson**, Eds., *Computational Imaging 2003*, SPIE Proceedings Series, 2003.

M. Rabbani and **R. L. Stevenson**, Eds., *Visual Communications and Image Processing 2009*, SPIE Proceedings Series, 2009.

A. Said, O. G. Guleryuz, and **R. L. Stevenson**, Eds., *Visual Information Processing and Communication II*, SPIE Proceedings Series, 2011.

A. Said, O. G. Guleryuz, and **R. L. Stevenson**, Eds., *Visual Information Processing and Communication III*, SPIE Proceedings Series, 2012.

A. Said, O. G. Guleryuz, and **R. L. Stevenson**, Eds., *Visual Information Processing and Communication IV*, SPIE Proceedings Series, 2013.

A. Said, O. G. Guleryuz, and **R. L. Stevenson**, Eds., *Visual Information Processing and Communication V*, SPIE Proceedings Series, 2014.

A. Said, O. G. Guleryuz, and **R. L. Stevenson**, Eds., *Visual Information Processing and Communication VI*, SPIE Proceedings Series, 2015.

A. Said, O. G. Guleryuz, and **R. L. Stevenson**, Eds., *Visual Information Processing and Communication VII*, IS&T, 2016.

R. L. Stevenson and E. Delp, Eds., *Visual Information Processing and Communication VIII*, IS&T, 2017.

C. Bouman and **R. L. Stevenson**, Eds., *Computational Imaging XV*, IS&T, 2017.

C. Bouman and **R. L. Stevenson**, Eds., *Computational Imaging XVI*, IS&T, 2018.

C. Bouman, G. T. Buzzard, and **R. L. Stevenson**, Eds., *Computational Imaging XVII*, IS&T, 2019.

C. Bouman, G. T. Buzzard, and **R. L. Stevenson**, Eds., *Computational Imaging XVIII*, IS&T, 2020.

C. Bouman, G. T. Buzzard, and **R. L. Stevenson**, Eds., *Computational Imaging XIX*, IS&T, 2021.

C. Bouman, G. T. Buzzard, and **R. L. Stevenson**, Eds., *Computational Imaging XX*, IS&T, 2022.

Conference Papers

G. R. Arce and **R. L. Stevenson**, “On the Synthesis of Median Filter Systems,” *Proceedings of the 1986 Princeton Conference on Information Sciences and Systems*, pp. 711–716, Princeton, New Jersey, March 1986.

R. L. Stevenson and G. R. Arce, “Theoretical Analysis of Morphological Filters,” *Proceedings of the 24th Annual Allerton Conference on Communication, Control, and Computing*, pp. 353–362, Allerton, IL, October 1986.

R. L. Stevenson and E. J. Delp, “Investigation into Building an Invariant Surface Model from Sparse Data,” *NATO ASI on Active Per-*

ception and Robot Vision, Maratea, Italy, July 16–29, 1989.

R. L. Stevenson, “Machine Vision Systems for Component Assembly and Measurements,” *Proceedings of the Fluid Power Technical Update Seminar*, pp. 98–107, West Lafayette, IN, August 2–4, 1989.

J. Song, **R. L. Stevenson**, and E. J. Delp, “The Use of Mathematical Morphology in Image Enhancement,” *Proceedings of the 32nd Midwest Symposium on Circuits and Systems*, pp. 67–70, Urbana, IL, August 14–16, 1989.

R. L. Stevenson and E. J. Delp, “Invariant Reconstruction of Visual Surfaces,” *Proceedings of the IEEE Workshop on the Interpretation of 3D Scenes*, pp. 131–137, Austin, TX, November 27–29, 1989.

R. L. Stevenson and E. J. Delp, “Fitting Curves with Discontinuities,” *Proceedings of the IEEE International Workshop on Robust Computer Vision*, pp. 127–136, Seattle, WA, October 1–3, 1990.

R. L. Stevenson, G. B. Adams, L. H. Jamieson and E. J. Delp, “Three-Dimensional Surface Reconstruction on the AT&T Pixel Machine,” *Proceedings of the 24th Annual Asilomar Conference on Signals, Systems and Computers*, pp. 544–548, Pacific Grove, CA, November 5–7, 1990.

R. L. Stevenson and E. J. Delp, “Invariant Reconstruction of 3D Curves and Surfaces,” *Proceedings of the SPIE Conference on Intelligent Robots and Computer Vision*, pp. 364–375, Boston, MA, November 4–9, 1990.

R. L. Stevenson and E. J. Delp, “Viewpoint Invariant Recovery of Visual Surfaces from Sparse Data,” *Proceedings of the Third International Conference on Computer Vision*, pp. 309–312, Osaka, Japan, December 4–7, 1990.

R. L. Stevenson and E. J. Delp, “Surface Reconstruction with Discontinuities,” *Proceedings of the SPIE Conference on Curves and Surfaces in Computer Vision and Graphics II*, pp. 46–57, Boston, MA, November 10–15, 1991.

R. L. Stevenson, “A Nonlinear Estimation Technique for Filtering Images Corrupted with Gaussian Noise,” *Proceedings of the SPIE/IS&T*

Conference on Nonlinear Image Processing III, pp. 210–221, San Jose, California, February 9–14, 1992.

R. R. Schultz and **R. L. Stevenson**, “Improved Definition Image Expansion,” *Proceedings of the 1992 International Conference on Acoustics, Speech and Signal Processing*, pp. III:173–176, San Francisco, California, March 23–26, 1992.

J. Wang, **R. L. Stevenson**, and Richard R. Schultz, “Recovery of Image Information from Halftone Information,” *Proceedings of the Fifth Digital Signal Processing Workshop*, pp. 6.3.1–6.3.2, Starved Rock State Park, IL, September 13–16, 1992.

R. R. Schultz and **R. L. Stevenson**, “Parameter Estimation for Discontinuity– Preserving Stochastic Signal Models,” *Proceedings of the Thirtieth Annual Allerton Conference on Communication, Control, and Computing*, pp. 319–328, Allerton, IL, September 30 – October 2, 1992.

S. M. Schweizer and **R. L. Stevenson**, “Predetection of Impulse Locations in a Mixed Noise Environment,” *Proceedings of the Third Annual Argonne Symposium for Undergraduates in Science, Engineering and Mathematics*, p. 73, Argonne National Laboratory, Argonne, IL, November 6–7, 1992.

S. M. Schweizer and **R. L. Stevenson**, “A Bayesian Approach to Inverse Halftoning,” *Proceedings of the SPIE/IS&T Conference on Human Vision, Visual Processing and Digital Display IV*, pp. 282–292, San Jose, CA, January 31 – February 5, 1993.

R. L. Stevenson, “Reduction of Coding Artifacts in Transform Image Coding,” *Proceedings of the 1993 International Conference on Acoustics, Speech and Signal Processing*, pp. V:401–404, Minneapolis, MN, April 27–30, 1993.

T. P. O’Rourke and **R. Stevenson**, “Human Visual System Based Subband Image Compression,” *Proceedings of the Thirty-First Annual Allerton Conference on Communication, Control, and Computing*, pp. 452–461, Allerton, IL, September 29 – October 1, 1993.

B. E. Schmitz and **R. L. Stevenson**, “Parameter Estimation for the Curve Recovery Problem,” *Proceedings of the Thirty-First Annual*

Allerton Conference on Communication, Control, and Computing, pp. 485–494, Allerton, IL, September 29 – October 1, 1993.

M. A. Lexa and **R. Stevenson**, “Filtering Video Sequences using Non-linear Techniques,” *Proceedings of the Fourth Annual Argonne Symposium for Undergraduates in Science, Engineering and Mathematics*, p. 83, Argonne National Laboratory, Argonne, IL, November 5–6, 1993.

M. P. Witzman, R. R. Schultz and **R. Stevenson**, “Computation of MAP Signal Estimates using a Gradient Descent Window Operator,” *Proceedings of the Fourth Annual Argonne Symposium for Undergraduates in Science, Engineering and Mathematics*, p. 84, Argonne National Laboratory, Argonne, IL, November 5–6, 1993.

T. P. O’Rourke and **R. Stevenson**, “Improved Image Decompression for Reduced Transform Coding Artifacts,” *Proceedings of the SPIE/IS&T Conference on Image and Video Processing, II*, pp. 90–101, San Jose, CA, February 6–10, 1994.

R. R. Schultz, S. Choi, **R. L. Stevenson**, Y. Huang, R. Liu and L. Morine, “Contrast Enhancement of Missile Data Through Image Sequence Stabilization and Product Correlation,” *Proceedings of the SPIE/IS&T Conference on Image and Video Processing, II*, pp. 164–175, San Jose, CA, February 6–10, 1994.

B. E. Schmitz and **R. L. Stevenson**, “Color Palette Restoration,” *Proceedings of the SPIE/IS&T Conference on Human Vision, Visual Processing and Digital Display, V*, pp. 327–338, San Jose, CA, February 6–10, 1994.

R. R. Schultz, H. M. Zayed, **R. L. Stevenson**, R. J. Minniti and G. H. Bernstein, “ASIC Design for Robust Signal and Image Processing,” *Proceedings of the Fourth Great Lakes Symposium on VLSI*, pp. 138–143, Notre Dame, IN, March 4–5, 1994.

T. L. Piatt and **R. L. Stevenson**, “The Use of Block-Matching Motion Estimation in Image Filtering,” appeared at the *National Conference on Undergraduate Research*, Western Michigan University, Kalamazoo, MI, April 14–16, 1994.

M. P. Witzman, R. R. Schultz and **R. L. Stevenson**, “Computation of Partial Signal MAP Estimates,” appeared at the *National Conference*

on Undergraduate Research, Western Michigan University, Kalamazoo, MI, April 14-16, 1994.

R. R. Schultz and **R. L. Stevenson**, “Stochastic Modeling and Estimation of Multispectral Image Data,” *Proceedings of the 1994 International Conference on Acoustics, Speech and Signal Processing*, pp. V:373–376, Adelaide, Australia, April 19–22, 1994.

R. R. Schultz and **R. L. Stevenson**, “A Window-Based Bayesian Estimator for Noise Removal,” *Proceedings of the 37th Midwest Symposium on Circuits and Systems*, pp. 860–863, Lafayette, LA, August 3–5, 1994.

R. R. Schultz, **R. L. Stevenson**, and A. Lumsdaine, “Maximum Likelihood Parameter Estimation for Non-Gaussian Prior Signal Models,” *Proceedings of the 1994 IEEE International Conference on Image Processing*, pp. II:700–704, Austin, TX, November 13–16, 1994.

R. R. Schultz and **R. L. Stevenson**, “Video Resolution Enhancement,” *Proceeding of the SPIE/IS&T Conference on Image and Video Processing, III*, pp. 23–34, San Jose, CA, February 5–10, 1995.

J. Squyres, A. Lumsdaine, and **R. L. Stevenson**, “Cluster-Base Image Processing,” *Proceedings of the SPIE/IS&T Conference on Image and Video Processing, III*, pp. 228–239, San Jose, CA, February 5–10, 1995.

R. R. Schultz and **R. L. Stevenson**, “Improved Definition Video Frame Enhancement,” *Proceedings of The 1995 IEEE International Conference on Acoustics, Speech and Signal Processing*, pp. 2169–2172, Detroit, MI, May 9–12, 1995.

T. P. O’Rourke, **R. L. Stevenson**, L. Perez, D. J. Costello, Jr., and Y.-F. Huang, “Robust Transmission of Compressed Images over Noisy Gaussian Channels,” *Proceedings of The 1995 IEEE International Conference on Acoustics, Speech and Signal Processing*, pp. 2319–2322, Detroit, MI, May 9–12, 1995.

R. L. Stevenson and R. R. Schultz (invited), “Extraction of High-Resolution Frames from Video Sequences,” *IEEE Workshop on Non-linear Image Processing*, pp. 718–721, Greece, June 20–22, 1995.

J. Squyres, A. Lumsdaine, and **R. L. Stevenson**, “A Parallel Image Processing Toolkit Using MPI,” *Proceedings the MPI Developers Con-*

ference, <http://www.cse.nd.edu/mpidc95/>, Notre Dame, IN, June 22-23, 1995.

R. L. Stevenson, “Reduction of Coding Artifacts in Low-Bit-Rate Video Coding,” *Proceedings of the 1995 Midwest Symposium on Circuits and Systems*, pp. 854–857, Rio de Janeiro, Brazil, August 1995.

B. E. Schmitz and **R. L. Stevenson**, “Color Space Expansion,” *Proceedings of the 1995 Midwest Symposium on Circuits and Systems*, pp. 133–136, Rio de Janeiro, Brazil, August 1995.

T. P. O’Rourke, **R. L. Stevenson**, D. J. Costello, Jr. and Y.-F. Huang, “Improved Decoding of Compressed Images Received over Noisy Channels,” *Proceedings of the 1995 IEEE International Conference on Image Processing*, pp. II:65–68, Washington, DC, October 1995.

R. R. Schultz and **R. L. Stevenson**, “Motion Compensated Scan Conversion of Interlaced Video Sequences,” *Proceedings of the SPIE/IS&T Conference on Image and Video Processing IV*, pp. 107–118, San Jose, CA, February 1996.

B. E. Schmitz and **R. L. Stevenson**, “Enhancement of Sub-Sampled Color Image Data,” *Proceedings of the SPIE/IS&T Conference on Image and Video Processing IV*, pp. 97–106, San Jose, CA, February 1996.

T. P. O’Rourke, and **R. L. Stevenson**, “Vector Quantization with Distance Constraints for Enhanced Post-Processing,” *Proceedings of the SPIE/IS&T Conference on Still Video Compression II*, pp. 9–20, San Jose, CA, February 1996.

J. M. Squyres, A. Lumsdaine, B. C. McCandless, and **R. L. Stevenson**, “Parallel and Distributed Algorithms for High Speed Image Processing,” *Proceedings of the Sixth Annual Dual-Use Technologies & Applications Conference*, pp. 185–190, Syracuse, NY, June 1996.

J. Brockman, S. Batill, J. Renaud, J. Kantor, D. Kirkner, P. Kogge, and **R. L. Stevenson**, “Development of a Multidisciplinary Engineering Design Laboratory at the University of Notre Dame,” *Proceedings of the ASEE Annual Conference*, Washington, D.C., June 1996.

R. R. Schultz and **R. L. Stevenson**, “Sub-Pixel Motion Estimation,”

Proceedings of the 1996 Midwest Symposium on Circuits and Systems, pp. 1385–1388, Ames, Iowa, August 1996.

R. Lladós-Bernaus and **R. L. Stevenson**, “Reduction of Coding Artifacts in Video Compression,” *Proceedings of the SPIE Internal Conference on Electronic Imaging and Signal Processing*, pp. 2–10, Beijing, China, November 1996.

R. Lladós-Bernaus and **R. L. Stevenson**, “A Robust Low-Bit Rate 3D Subband Codec,” *Proceedings of the SPIE/IS&T Internal Conference on Visual Communications and Image Processing*, pp. 610–521, San Jose, CA, February 1997.

R. R. Schultz, L. Meng, and **R. L. Stevenson**, “Subpixel Motion Estimation for Multiframe Resolution Enhancement,” *Proceedings of the SPIE/IS&T Internal Conference on Visual Communications and Image Processing*, pp. 1317–1328, San Jose, CA, February 1997.

M. J. Wahoske, R. W. Liu, and **R. L. Stevenson**, “Dual-Receiver Blind Identification for Image Blurs,” *Proceedings of the 1997 IEEE International Conference on Circuit and Systems*, vol. 2, pp. 1377–1380, Hong Kong, June 1997.

R. Lladós-Bernaus and **R. L. Stevenson**, “Addition of Robustness to Standard Video Compression Protocols”, *Proceedings of the IEEE Midwest Symposium on Circuits and Systems*, pp. 921–924, Sacramento, CA, August 1997.

R. Lladós-Bernaus and **R. L. Stevenson**, “Fixed Length Entropy Coding for Robust Video Compression”, *Proceedings of the IEEE International on Image Processing*, Vol. II, pp. 97–100, Santa Barbara, CA, October 1997.

R. Schultz and **R. L. Stevenson**, “Bayesian Estimation of Subpixel-Resolution Motion Fields and High-Resolution Video Stills,” *Proceedings of the IEEE International Conference on Image Processing*, Vol. III, pp. 62–65, Santa Barbara, CA, October 1997.

J. He, D. Costello, Y. F. Huang, and **R. L. Stevenson**, “On the Application of Turbo Codes to the Robust Transmission of Compressed Images,” *Proceedings of the IEEE International Conference on Image Processing*, Vol. III, pp. 559–562, Santa Barbara, CA, October 1997.

Z. Peng, Y. F. Huang, D. Costello, and **R. L. Stevenson**, “Image Compression using Region-Activity-Based Pyramidal Coding and Iterative Vector Quantizer,” *Proceedings of the IEEE International Conference on Image Processing*, Vol. III, pp. 698–701, Santa Barbara, CA, October 1997.

R. Lladós-Bernaus and **R. L. Stevenson**, “Edge-Assisted Upper Bands Coding Techniques”, *Proceedings of the SPIE/IS&T International Conference on Visual Communications and Image Processing*, pp. 2–13, San Jose, CA, January 1998.

Z. Peng, Y. F. Huang, D. Costello, and **R. L. Stevenson**, “Joint Source/Channel Decoding for Image Transmission – A Turbo Code Approach,” *Proceedings of the Conference on Information Sciences and Systems*, pp. 330–335, Princeton, NJ, March 1998.

R. Lladós-Bernaus and **R. L. Stevenson**, “Codeword Assignment for Fixed-Length Entropy Coded Video Streams”, *IEEE Data Compression Conference*, pp. 269–275, Snowbird, UT, March 1998.

R. R. Schultz and **R. L. Stevenson**, “Estimation of Subpixel-Resolution Motion Fields from Segmented Image Sequences”, *Proceedings of the SPIE International Conference on Sensor Fusion: Architectures, Algorithms, and Applications II*, pp. 90–101, Orlando, FL, April 1998.

Z. Peng, Y. F. Huang, D. Costello, and **R. L. Stevenson**, “Joint Channel and Source Decoding for Vector Quantized Images using Turbo Codes,” *Proceedings of the IEEE International Symposium on Circuits and Systems*, pp. IV:5–8, Monterey, CA, May 1998.

J. M. Squires, A. Lumsdaine and **R. L. Stevenson**, “A Toolkit for Parallel Image Processing, *Proceedings of the SPIE International Conference on Parallel and Distributed Methods for Image Processing II*, pp. 69–71, San Diego, CA, July 1998.

R. Lladós-Bernaus and **R. L. Stevenson**, “Bidirectional Block Placement in Corrupted Fixed-Length Entropy Coded Video Streams”, *Proceedings of the IEEE Midwest Symposium on Circuits and Systems*, pp. 391–394, Notre Dame, IN, August 1998.

M. Robertson and **R. L. Stevenson**, “Reducing the Complexity of Iterative Post-Processing of Video,” *Proceedings of the IEEE Midwest*

Symposium on Circuits and Systems, pp. 399–402, Notre Dame, IN, August 1998.

S. Borman and **R. L. Stevenson**, “Super-Resolution Still from Image Sequences – A Review,” *Proceedings of the IEEE Midwest Symposium on Circuits and Systems*, pp. 374–378, Notre Dame, IN, August 1998.

Z. Peng, Y. F. Huang, D. Costello, and **R. L. Stevenson**, “Joint Decoding for Turbo Codes for Subband Coded Image,” *Proceedings of the IEEE International Conference on Image Processing*, pp. I:329–333, Chicago, IL, October 1998.

M. Robertson and **R. L. Stevenson**, “Reducing the Complexity of a MAP Post-Processing Algorithm for Video Sequences,” *Proceedings of the IEEE International Conference on Image Processing*, pp. I:372–376, Chicago, IL, October 1998.

Z. Peng, Y. F. Huang, D. Costello, and **R. L. Stevenson**, “On the Tradeoff Between Source and Channel Coding Rates for Image Transmission,” *Proceedings of the IEEE International Conference on Image Processing*, pp. II:118–121, Chicago, IL, October 1998.

R. Lladós-Bernaus and **R. L. Stevenson**, “Computationally Efficient Fixed-Length Entropy Codec for Robust Video Compress,” *Proceedings of the IEEE International Conference on Image Processing*, pp. III:85–89, Chicago, IL, October 1998.

S. Borman, M. Robertson, and **R. L. Stevenson**, “Block-Matching Sub-Pixel Motion Estimation from Noisy Under-Sampled Frames – An Empirical Performance Evaluation,” *Proceedings of the SPIE/IS&T Conference on Visual Communication and Image Processing '99*, Vol. 3653, pp. 1442–1451, January 25–27, 1999.

M. A. Robertson, S. Borman, and **R. L. Stevenson**, “Dynamic Range Improvement Through Multiple Exposures,” *Proceedings of the International Conference on Image Processing*, pp. III:159–163, Kobe, Japan, October 1999.

S. Borman and **R. L. Stevenson**, “Simultaneous Multi-frame MAP Super-Resolution Video Enhancement using Spatio-temporal Priors,” *Proceedings of the International Conference on Image Processing*, pp. III:469–473, Kobe, Japan, October 1999.

M. A. Robertson and **R. L. Stevenson**, “Restoration of Compressed Video using Temporal Information,” *Proceedings of the SPIE/IS&T Visual Communications and Image Processing 2001*, pp. 21–29, San Jose, CA, January 2001.

M. A. Robertson and **R. L. Stevenson**, “Temporal Resolution Enhancement in Compressed Video,” *Nonlinear Signal and Image Processing 2001*, Baltimore, MD, June 2001.

M. A. Robertson and **R. L. Stevenson**, “DCT Quantization Noise in Compressed Images,” *Proceedings of the International Conference on Image Processing 2001*, Thessaloniki, Greece, pp. 185–188, October, 2001.

K. Erickson and **R. L. Stevenson**, “Frame Type Selection for Off-Line MPEG Encoding,” *Proceedings of SPIE/IS&T Visual Communications and Image Processing 2001*, San Jose, CA, pp. 406–414, January 2002.

D. P. Bennett, J. Bally, I. Bond, E. Cheng, K. Cook, D. Deming, P. Garnavich, K. Griest, D. Jewitt, N. Kaiser, T. R. Lauer, J. Lunine, G. Luppino, J. C. Mather, D. Minniti, S. J. Peale, S. H. Rhie, J. Rhodes, J. Schneider, G. Sonneborn, **R. Stevenson**, C. Stubbs, D. Tenerelli, N. Woolf, and P. Yock, “The Galactic Exoplanet Survey Telescope (GEST)”, *Proceedings of the SPIE International Conference on Future EUV/UV and Visible Space Astrophysics Missions and Instrumentation*, pp. 141–155, Waikoloa, HI, August 2002.

R. Magill, C. E. Rohrs, and **R. L. Stevenson**, “Revisiting Output Queued Switch Emulation by a Combined Input/Output Queued Switch,” *Proceedings of the Fortieth Annual Allerton Conference on Communication, Control, and Computing*, Allerton, IL, October 2 – 4, 2002.

R. Magill, C. E. Rohrs, and **R. L. Stevenson**, “Output Queued Switch Emulation by a Buffered Crossbar Fabric,” *Proceedings of the Fortieth Annual Allerton Conference on Communication, Control, and Computing*, Allerton, IL, October 2 – 4, 2002.

S. Borman and **R. L. Stevenson**, “Image resampling and constraint formulation for multi-frame super-resolution restoration,” *Proceedings of the SPIE/IS&T Conference on Computational Imaging II*, Santa Clara, CA, pp. 234–245, January 20 – 24, 2003.

G. Zhang and **R. L. Stevenson**, “A Modified Fixed-Length Entropy Coding Algorithm for Robust Video Compression,” *Proceedings of the SPIE/IS&T Conference on Image and Video Communications and Processing 2003*, Santa Clara, CA, pp. 470–478, January 20 – 24, 2003.

S. Borman and **R. L. Stevenson**, “Linear models for multi-frame super-resolution restoration under non-affine registration and spatially varying PSF,” *Proceedings of the SPIE/IS&T Conference on Computational Imaging*, San Jose, CA, January 18 – 22, 2004.

G. Zhang, and **R. L. Stevenson**, “Efficient Error Recovery for Multiple Description Video Coding,” *Proceedings of the International Conference on Image Processing 2004*, Singapore, pp. 829–832, October, 2004.

G. Zhang and **R. L. Stevenson**, “Error Resilient Video Coding Using Virtual Reference Picture,” *Proceedings of the SPIE/IS&T Conference on Image and Video Communications and Processing 2005*, San Jose, CA, pp. 896–903, January 18–20, 2005.

G. Zhang, **R. L. Stevenson**, “Hybrid Scalable Video Coding with Multiple Description and Layered Coding,” *Proceedings of the SPIE/IS&T Conference on Visual Communications and Image Processing 2006*, San Jose, CA, January 2006.

Y. Li, **R. L. Stevenson**, J. Gai, “Detection of Junction in Images,” *Proceeding of the SPIE/IS&T Conference on Image Processing: Algorithms and Systems V*, San Jose, CA, February 2007.

Y. Li, **R. L. Stevenson**, “Multimodal Image Registration Based on Edges and Junctions,” *Proceeding of the SPIE/IS&T Conference on Visual Communications and Image Processing 2007*, San Jose, CA, January 2007.

J. Gai and **R. L. Stevenson**, “A Robustified Hidden Markov Model for Visual Tracking with Subspace Representation,” *Proceeding of the SPIE/IS&T Conference on Visual Communications and Image Processing 2007*, San Jose, CA, January 2007.

Y. , **R. L. Stevenson**, and J. Gai “Corner-Guided Image Registration by using Edges,” *Proceedings of the International Conference on Image Processing 2007*, San Antonio, TX, pp. V:361–364, September, 2007.

J. Gai, Y. Li, and **R. L. Stevenson**, “Coupled Hidden Markov Models for Robust EO/IR Target Tracking,” *Proceedings of the International Conference on Image Processing 2007*, San Antonio, TX, pp. I:41-44, September, 2007.

Y. Li, **R. L. Stevenson**, and J. Gai, “Line segment based image registration,” *Proceeding of the SPIE/IS&T Conference on Visual Communications and Image Processing 2008*, San Jose, CA, January 2008.

J. Gai, Y. Li, and **R. L. Stevenson**, “Robust Bayesian PCA with Students t-distribution: The variational inference approach,” *Proceedings of 15th IEEE International Conference on Image Processing*, pp. 1340 - 1343, San Diego, CA, October 2008.

J. Gai, Y. Li, and **R. L. Stevenson**, “An EM algorithm for robust Bayesian PCA with students t-distribution,” *Proceedings of 15th IEEE International Conference on Image Processing*, pp. 2672 - 2675, San Diego, CA, October 2008.

Y. Li, **R. L. Stevenson**, and J. Gai, “Curve matching in the framework of Riemannian geometry,” *Proceeding of the SPIE/IS&T Conference on Visual Communications and Image Processing 2009*, San Jose, CA, January 2009.

J. Gai and **R. L. Stevenson**, “Contour Tracking BASd On A Synergetic Approach of Geodesic Active Contours and Conditional Random Fields,” *Proceedings of the 17th IEEE International Conference on Image Processing*, Hong Kong, China, September, 2010.

J. Gai and **R. L. Stevenson**, “Optical Flow Estimation With p-Harmonic Regularization,” *Proceedings of the 17th IEEE International Conference on Image Processing*, Hong Kong, China, September, 2010.

Y. Li and **R. L. Stevenson**, “Affine image registration with curve mapping,” *Proceedings of the SPIE/IS&T Conference on Visual Information Processing and Communication II*, San Francisco, CA, January 2011.

J. D. Simpkins and **R. L. Stevenson**, “Robust Grid Registration for Non-Blind PSF Estimation,” *Proceedings of the SPIE/IS&T Conference on Visual Information Processing and Communication III*, San Francisco, CA, January 2012.

Y. Li and **R. L. Stevenson**, “A Similarity Metric for Multimodal Images Based on Modified Hausdorff Distance,” *Proceedings of the 9th IEEE International Conference on Advanced Video and Signal-Based Surveillance*, Beijing, China, September 2012.

J. D. Simpkins and **R. L. Stevenson**, “Mapping Measurable Qualities of Point-Spread Function Observations to Seidel Aberration Coefficients,” *Proceedings of the 18th International Conference on Image Processing*, Orlando, FL, September 2012.

Y. Li and **R. L. Stevenson**, “Multimodal Image Registration By Iteratively Searching Keypoint Correspondences,” *Proceedings of the SPIE/IS&T Conference on Visual Information Processing and Communication IV*, San Francisco, CA, February 21, 2013.

J. D. Simpkins and **R. L. Stevenson**, “A Spatially-Varying PSF Model for Seidel Aberrations and Defocus,” *Proceedings of the SPIE/IS&T Conference on Visual Information Processing and Communication IV*, San Francisco, CA, February 21, 2013.

Y. Li and **R. L. Stevenson**, “Register multimodal images of range information,” *Proceedings of the SPIE/IS&T Conference on Visual Information Processing and Communication V*, San Francisco, CA, February 17, 2014.

J. D. Simpkins and **R. L. Stevenson**, “Register Multimodal Images of Range Information,” *Proceedings of the SPIE/IS&T Conference on Visual Information Processing and Communication V*, San Francisco, CA, February 17, 2014.

R. Zhen and **R. L. Stevenson**, “Joint Deblurring and Demosaicking of Raw Image Data With Motion Blur” *Proceedings of the SPIE/IS&T Conference on Visual Information Processing and Communication V*, San Francisco, CA, February 17, 2014.

R. Zhen and **R. L. Stevenson**, “Motion Blur Kernel Estimation Using Noisy Inertial Data,” *Proceedings of the IEEE International Conference on Image Processing*, Paris, France, pp. 4602-6, October 27, 2014.

R. Zhen and **R. L. Stevenson**, “Semi-blind Deblurring Images Captured with Electronic Rolling Shutter Mechanism,” *Proceedings of the SPIE/IS&T Conference on Visual Information Processing and Com-*

munication VI, February 2015.

J. D. Simpkins and **R. L. Stevenson**, “Parameterized modeling and estimation of spatially varying optical blur,” *Proceedings of SPIE/IS&T Conference on Digital Photography and Mobile Imaging XI*, February 2015.

R. Zhen and **R. L. Stevenson**, “Motion debarring for depth-varying scenes,” *IS&T Conference on Visual Information Processing and Communication VII*, February 2016.

H. Jin, Y. Li, and **R. L. Stevenson**. “Register Multimodal Image of Large Scene Depth Variation with Global Information,” *IS&T Conference on Visual Information Processing and Communication VII*, February 2016.

R. Zhen and **R. L. Stevenson**, “Motion Deblurring and Depth Estimation From Multiple Images,” *Proceedings of the IEEE International Conference on Image Processing*, Phoenix, Arizona, , September 25-29, 2016.

L. N. Kloepper, Y. Fu, M. Kinniry, **R. L. Stevenson**, C. H. Brighton, P. Domski, C. Harding, and G. K. Taylor, “Hawks, ziplines, and drones: new methods for recording echolocation of bats in large groups,” *North American Society for Bat Research*, Knoxville, TN, October 2017.

L. N. Kloepper, Y. Fu, M. Kinniry, **R. L. Stevenson**, C. H. Brighton, P. Domski, C. Harding, and G. K. Taylor, “Sensing in streams and swarms: echolocation of bats in large groups,” *XXVI International Bioacoustics Council Meeting*, Hardiwar, India, October 2017.

S. Zhang and **R. L. Stevenson**, “Intertia Sensor Aided Alignment for Burst Pipeline in Low Light Conditions,” *Proceedings of the IEEE International Conference on Image Processing*, Athens, Greece, , October 7-10, 2018.

S. Zhang and **R. L. Stevenson**, “GAN Based Image Deblurring Using Dark Channel Prior,” *IS&T Conference on Computational Imaging XVII*, January 2019.

R. Izadi, **R. L. Stevenson**, and L. Kloepper, “Segmentation of overlapping sources in mixtures of bat echolocation calls,” *178th Meeting*

of the Acoustical Society of America, December 2019.

J. Li and **R. L. Stevenson**, “Indoor Layout Estimation by 2D LiDAR and Camera Fusion,” *IS&T Conference on Computational Imaging XVIII*, January 2020.

S. Zhang and **R. L. Stevenson**, “A Dataset for Deep Imaging Deblurring Aided by Inertial Sensor Data,” *IS&T Conference on Computational Imaging XVIII*, January 2020.

M. R. Izadi, Y. Fang, **R. Stevenson**, and L. Lin, “Optimization of Graph Neural Networks with Natural Gradient Descent,” *2020 IEEE International Conference on Big Data*, December 2020.

R. Izadi, **R. L. Stevenson**, and L. Kloepper, “Affinity Mixup for Weakly Supervised Sound Event Detection,” *IEEE 31st International Workshop on Machine Learning for Signal Processing (MLSP)*, October 25-28, 2021.

J. Li and **R. L. Stevenson**, “2D LiDAR and Camera Fusion Using Motion Cues for Indoor Layout Estimation,” *24th International Conference on Information Fusion*, Sun City, South Africa, November 1-4, 2021.

J. Li, Zhen, R. and **R. L. Stevenson**, “A lightweight exposure bracketing strategy for HDR imaging without access to camera raw,” *IS&T Conference on Computational Imaging XXI*, January 2023.

Patents

“Video Coding using a Maximum A Posteriori Loop Filter,” U.S. Patent 6,081,552, June 27, 2000.

Invited Talks

“Bayesian Techniques for Image Restoration,” Department of Electrical Engineering and Computer Science, Washington State University, Pullman, WA, March 27, 1992.

“Reconstruction and Enhancement of Image and Video Data,” Hewlett Packard Research Laboratory, Palo Alto, CA, October 12, 1993.

“Stochastic Image Modeling for Image Enhancement,” Department of Electrical Engineering and Computer Science, University of California,

Berkeley, CA, February 10, 1994.

“Stochastic Image Modeling for Image Enhancement,” Department of Electrical Engineering and Computer Science, Northwestern University, IL, May 31, 1994.

“Bayesian Estimation Techniques for Image/Video Processing,” Intel Corp., Hillsboro, OR, Part I July 7, 1994, Part II July 21, 1994.

“HVS Based Image Compression,” Intel Corp., Hillsboro, OR, August 18, 1994.

“Bayesian Estimation Techniques for Image/Video Processing,” Tektronix Inc., Beaverton, OR, August 19, 1994.

“Bayesian Estimation Techniques for Image/Video Processing,” Intel Corp., Santa Clara, CA, August 23, 1994.

“Post-Processing MRV Video Data,” Intel Corp., Hillsboro, OR, August 25, 1994.

“Improved Robust Image/Video Communication,” Motorola Corp., Schaumburg, IL, February 21, 1995.

“Stochastic Modeling of Color Image Data,” Xerox Corp., Webster, NY, May 24, 1995.

“Multi-Frame Integration for Video Enhancement,” Kodak Corp., Rochester, NY, August 4, 1995.

“Bayesian Estimation Techniques for Image/Video Processing,” Ricoh California Research Center, Palo Alto, CA, February 3, 1996.

“Bayesian Estimation Techniques for Image/Video Processing,” University of Delaware, Newark, DE, October 10, 1996.

“Issues in Video Compression,” Intel Corporation, Hillsboro, OR, June 21, 1997.

“Techniques for High-Speed Image Enhancement,” Sun Microsystems, Sunnyvale, CA, May 21, 1998.

“Stochastic Modeling for Image/Video Processing,” Purdue University, West Lafayette, IN, Nov. 12, 1998.

“High Performance Multimedia Applications Reserach,” Sun Microsystems, Sunnyvale, CA, Jan. 25, 1999.

“Video over the Internet,” D. E. Shaw & Co., New York, NY, May 4, 2000.

“Entertainment Video over the Internet,” Sun Microsystems, Sunnyvale, CA, Nov. 16, 2000.

“The Creative Scientist,” Keynote address at 16th Annual Undergraduate Research Symposium, University of Delaware, Newark, DE, May 5, 2001.

“Super-Resolution Camera Systems,” Thomson Consumer Electronics, Indianapolis, IN, November 28, 2001.

“Three-Dimensional Signal Processing,” Air Force Research Laboratory, Rome, New York, September 26, 2002.

“Bayesian Image and Video Restoration,” ECE Distinguished Speaker Seminar Series at the Illinois Institute of Technology, October 24, 2003.

“Error Resilient Video Coding,” Purdue University, West Lafayette, IN, May 17, 2005.

“Robust Video Compression Using Multiple Description Coding,” Indiana University-Purdue University Indianapolis, Indianapolis, IN, November 2, 2006.

“Bayesian-Based Image and Video Enhancement,” Digimarc Corporation, Beaverton, OR, July 27, 2011.

Dissertations/Theses Supervised

Ph.D. Dissertations

R. R. Schultz, “Multichannel Stochastic Image Models: Theory, Applications, and Implementations,” Ph.D. Dissertation, University of Notre Dame, November 1994.

T. P. O’Rourke, “Robust Image Communication: An Improved Design,” Ph.D. Dissertation, University of Notre Dame, January 1996.

B. E. Schmitz, “Enhancement of Sub-Sampled Color Image Data,” Ph.D. Dissertation, University of Notre Dame, March 1996.

R. Lladós-Bernaus, “Entropy Coding Techniques for Robust Video Compression,” Ph.D. Dissertation, University of Notre Dame, March 1998.

M. A. Robertson, “High-Quality Reconstruction of Digital Image and Video from Imperfect Observations,” Ph.D. Dissertation, University of Notre Dame, April 2001.

R. Magill, “Emulating an Output Queued Packet Switch with Systems Containing Input and Output Queueing,” Ph.D. Dissertation, University of Notre Dame, May 2003.

K. Erickson, “Quality Optimization of Standards - Compliant Encoded Video,” Ph.D. Dissertation, University of Notre Dame, May 2003.

S. Borman, “Topics in Multiframe Superresolution Restoration,” Ph.D. Dissertation, University of Notre Dame, May 2004.

G. Zhang, “Robust Scalable Video Compression Using Multiple Description Coding,” Ph.D. Dissertation, University of Notre Dame, May 2007.

J. Gai, “Robust Target Tracking: Theory, Applications and Implementations,” Ph.D. Dissertation, University of Notre Dame, May 2010.

Y. Li, “Multimodal Image Registration Through Iteratively Searching Correspondences of Keypoints and Line Segments,” Ph.D. Dissertation, University of Notre Dame, December 2012.

J. Simpkins, “Modeling, Approximation, and Estimation of Spatially-Varying Blur in Photographic Systems,” Ph.D. Dissertation, University of Notre Dame, May 2016.

L. Hollmann, “Modeling, Approximation, and Estimation of Spatially-Varying Blur in Photographic Systems,” Ph.D. Dissertation, University of Notre Dame, November 2016.

R. Zhen, “Aided Blind Deblurring Image Degraded by Motion Blur,” Ph.D. Dissertation, University of Notre Dame, February 2017.

S. Zhang, “Deep Image Deblurring Networks Aided by Auxiliary Information,” Ph.D. Dissertation, University of Notre Dame, August 2021.

J. Li, “Information Fusion for Machine Perception in Challenging Environments,” Ph.D. Dissertation, University of Notre Dame, May 2023.

M.S.E.E. Theses

R. R. Schultz, “Improved Definition Image Expansion,” M.S.E.E. Thesis, University of Notre Dame, January 1992.

T. P. O'Rourke, "Human Visual Based Wavelet Decomposition for Image Compression," M.S.E.E. Thesis, University of Notre Dame, December 1992.

B. E. Schmitz, "Curve Reconstruction: A Balance Between Smoothness and Discontinuity Preservation," M.S.E.E. Thesis, University of Notre Dame, February 1993.

H. M. Zayed, "A Tunable Analog VLSI Network for Preserving Discontinuities in One-Dimensional Signals," M.S.E.E Thesis, University of Notre Dame, November 1993 (co-adviser: G. Bernstein).

M. J. Wahoske, "Dual-Receiver Blind Identification for Image Blurs," M.S.E.E Thesis, University of Notre Dame, August 1996 (co-adviser: R. Liu).

M. Robertson, "Computationally Efficient Post-Processing of Compressed Video Streams," M.S.E.E Thesis, University of Notre Dame, February 1998.

G. Zhang, "Modified Fixed-Length Entropy Coding for Robust Video Compression," M.S.E.E Thesis, University of Notre Dame, December 2002.

J. D. Simpkins, "Modeling and Estimation of Spatially-Varying Point-Spread Functions Due to Lens Aberrations and Defocus," M.S.E.E. Thesis, University of Notre Dame, December 2011.

R. Zhen, "Enhanced Raw Image Capture and Deblurring," M.S.E.E. Thesis, University of Notre Dame, May 2013.

Current Research Students

Mohammad Rasool Izadi

Research Funding

Current Funding

Principal Investigator, EE Chair Fund, \$575,000 for "Video Enhancement Research."

Prior Funding

Principal Investigator, Jesse H. Jones Faculty Research Fund, University of Notre Dame, \$9,750 for “Reliable Surface Parameter Estimation in Three-Dimensional Vision,” (with P. Flynn).

Principal Investigator, Jesse H. Jones Faculty Research Equipment Fund, University of Notre Dame, \$7,675 for “Hardware for the Acquisition and Display of Real-Time Video Signals,” (with K. Sauer).

Co-Principal Investigator, Rome Laboratory, F30602-92-C-0138, \$85,000 for “Multi-Frame Integration,” (with Y. Huang and R. Liu).

Co-Principal Investigator, National Science Foundation, CDA92-22905, \$58,126 for a “High Resolution Video Processing System,” (with D. Costello, K. Sauer, P. Bauer, Y. Huang and R. Liu).

Principal Investigator, Indiana Space Grant Consortium, \$7,300 for “Real-Time Vision for Teleoperated Control of Unmanned Vehicles and Robots,” \$7,500 for “Robust Video Coding,” \$5,889 for “Robust Video Coding,”

Principal Investigator, Apple Computer, Inc., \$15,000 for “Color Palette Restoration,” \$16,467 equipment donation.

Co-Principal Investigator, Office of University Computing, University of Notre Dame, \$20,000 for “Computing for System Engineering,” (with D. Costello and A. Lumsdaine).

Co-Principal Investigator, National Aeronautics and Space Administration, NASA-NAG 3-1549, \$50,795 for “Integrated System Design for the Transmission of Image Data over Low Bit Rate Noisy Channels,” (with D. Costello and Y. Huang).

Principal Investigator, Rome Laboratory, F30602-94-1-0017, \$35,408 for “Multi-Frame Integration for the Extraction of High Resolution Still Images from Video Sequences.”

Principal Investigator, Rome Laboratory, F30602-94-1-0016, \$50,785 for “Parallel and Distributed Algorithms for High-Speed Image Processing,” (with A. Lumsdaine).

Principal Investigator, Intel Corp., \$68,000 for “Post-Processing Com-

pressed Video Data,” \$15,000 equipment donation.

Co-Principal Investigator, Lockheed Martin, \$150,000 for “Robust Transmission of Images over Noisy Channels,” (with D. Costello and Y. Huang).

Principal Investigator, Apple Computer, Inc., \$19,100 for “Quicktake Image Enhancement,” \$15,000 equipment donation.

Co-Principal Investigator, Office of University Computing, University of Notre Dame, \$21,600 for “Multidisciplinary Engineering Design Laboratory,” (with J. Brockman, J. Kantor, J. Renaud, D. Kirkner, S. Batill, and P. Kogge).

Principal Investigator, Motorola Corp., \$91,252 for “Robust Transmission of Image Data over Low-Bit-Rate Noisy Channels,” (with D. Costello, R. Liu and Y. Huang).

Principal Investigator, Rome Laboratory, F30602-96-C-0235, \$199,964 for “Parallel and Distributed Algorithms for High-Speed Image Processing,” (with A. Lumsdaine).

Co-Principal Investigator, Office of University Computing, University of Notre Dame, \$23,000 for “An ATM Network for High-Speed Communications,” (with A. Lumsdaine).

Principal Investigator, Sun Microsystems, \$21,400 for “VIS-Based Image Enhancement.”

Co-Principal Investigator, IBM, \$309,544 for “Scalable Shared Memory: Case Studies,” (with A. Lumsdaine, N. Chrisochoides, J. Westerink, E. Maginn, M. Stadtherr).

Co-Principal Investigator, Army Research Office, DAAG55-98-1-0091, \$250,000 for “Scalable Meta-Computing for Computational Science and Engineering,” with A. Lumsdaine, N. Chrisochoides, J. Westerink, E. Maginn, M. Stadtherr).

Principal Investigator, Graduate School, University of Notre Dame, \$71,980 for “High-Resolution Video Processing,”.

Principal Investigator, Department of Defense, MDA904-98-C-B224, \$124,150 for “Temporal Image Enhancement,” (with A. Lumsdaine).

Co-Principal Investigator, Graduate School, University of Notre Dame, \$215,000 for “Scalable Meta-Computing for High Performance Computational Science and Engineering,” (with A. Lumsdaine, N. Chrisochoides, J. Westerink, E. Maginn, M. Stadtherr).

Principal Investigator, Sun Microsystems, \$55,060 for “Multimedia Architectures.”

Principal Investigator, Graduate School, University of Notre Dame, \$75,000 for “Sun Microsystems Embedded Center.”

Co-Principal Investigator, Indiana’s 21st Century Research & Technology Fund, \$829,714 for “Entertainment Video over the Internet,” (with E. Delp, B. Beyers, C. Rosenberg, P. Salama, and N. Shroff).

Principal Investigator, Sun Microsystems, \$40,000 for “Entertainment Video.”

Co-Principal Investigator, National Science Foundation, \$248,887 for “Instrumentation for Multidimensional Imaging and Applications”, (P. Flynn, K. Bowyer, and D.Z. Chen).

Principal Investigator, Department of the Air Force, \$75,000 for “Multi-Source Image Correlation and Analysis,” (with P. Flynn, and K. Bowyer).

Co-Principal Investigator, Indiana’s 21st Century Research & Technology Fund, \$856,576 for “Advanced Digital Video Compression: New Techniques for Security Applications,” (with E. Delp, L. Christopher, B. Brenner, C. Armstrong, and P. Salama).

Principal Investigator, Office of Naval Research, \$39,461 for “Biologically Inspired Approaches to Overcome Mutual-Interference by Active Sensor Systems.”

Principal Investigator, Office of Naval Research, \$54,073 for “Signal Processing Methods to Isolate Individual Bat FM calls from within the noise of a swarm.”

Teaching and Course Development

EE220	Devices and Systems in Electrical Engineering
	Developed: Fall 1998

	Taught: Fall 1998, 1999, 2000
EE224/EE20224	Introduction to Electrical Engineering Taught: Fall 1990, 1992, 1995, 1999, 2000, 2006, 2007, 2008
EE242/EE20242	Electronic Circuits Taught: Spring 2001, 2002, 2003, 2004, 2005
EE30363	Random Phenomena in Electrical Engineering Taught: Spring 2010, 2011, 2012, 2013
EE20231	Digital Systems Developed: Spring 2023 Taught: Spring 2023, Summer 2023
EE30321	Embedded Systems Developed: Spring 2016 Taught: Spring 2016, 2017, 2018, 2019, 2020, 2021, 2022
EE40354	Multimedia Signals and Systems Developed: Fall 2012 Taught: Fall 2012, 2016, 2017, 2018, 2019, 2020, 2021, 2022; Spring 2014
EE471/EE40471	Digital Signal Processing Taught: Spring 1992, 1993, 1995, 1996, 2000, 2008
EG498	Multidisciplinary Engineering Design Laboratory Developed: Fall 1995 Taught: Fall 1995
EE498	Topics in Image Processing Taught: Fall 1994
EE573/EE60573	Random Processing, Estimation and Detection Theory Taught: Spring 2007, 2009
EE581/EE60581	Digital Image Processing Taught: Spring 1991, 1994, 1999, 2006, 2015; Fall 1997, 2001, 2003, 2010
EE598/EE60671	Advanced Digital Signal Processing Developed: Fall 2004 Taught: Fall 2004, 2005, 2011, 2013, 2014
EE598	Computer Vision Developed: Fall 1991

	Taught: Fall 1991, 1993
EE663/EE80663	Advanced Stochastic Processes Developed: Spring 1998 Taught: Spring 1998, Fall 2002, 2009
ELEG631	Applications of Digital Signal Processing Developed: Fall 1996 Taught: Fall 1996, University of Delaware
CSE498P	Digital Multimedia Hub System Design Developed: Spring 2003 Taught: Spring 2003

University Services

University

Chair, Science and Technology Subcommittee of the Core Curriculum
Committee
2018–2022

Core Curriculum Committee
2018–2022

Club Supervisor, Notre Dame Machine Learning Club
2018–Present

Committee on Advising
2018–2019

Club Supervisor, Rubik’s Cube Club of Notre Dame
2011–2015

University Committee on Research and Sponsored Programs
2006–2010

Intellectual Property Committee
2003–2006

ND’s Technical Liaison to the Indiana Governor for Sun Microsystems
2000–2001

Committee on Technical Computing
1995–1996

University Committee on Computer and Information Sciences
1995–1996, 2002–2003

University Committee on Academic Technology
2003–2006

Faculty Senate
1993–1996

Freshman Orientation

1993–1995, 1998–2007, 2021–Present
Ad-hoc College of Engineering and Science DUS Committee 2022–
Present

Engineering College

Undergraduate Curriculum Committee
2021–Present
Ad-hoc Committee on First Year Engineering
2018–2019
Four Horsemen Venture Capital Fund Advisory Committee
2003–2004
CSE Chairman Search Committee
1999–2001
College Council
1997–2000
Undergraduate Studies Committee
1994–1996, 1998–1999, 2013–Present
College Computer Committee
1995–1996, 1997–2013
Ad hoc College Computer Committee
2001–2002, 2007
Friends of the MEP mentoring initiative
1992

Electrical Engineering Department

Ad-hoc Committee on the Curriculum
2017–2022
Director of Undergraduate Studies
2014–Present
ABET Coordinator
2016–2017, 2022–2023
Committee on Appointments and Promotions
2007–2009, 2017–Present
Area Committee Chairman
2002–2013
Graduate Committee
1991–1994, 2003–2005, 2006–2008, 2010–2012
Undergraduate Committee
1994–1996, 1998–2000, 2001–2003, 2005–2007, 2011–Present
Undergraduate Coordinator
1994–1996, 1998–1999
Undergraduate Mentor

2006–2014
Qualifying Exam Coordinator
1991–1993
Computer Committee, Chair
1994–1996, 1997–2013
Electrical Engineering Commencement Coordinator
2002, 2013–Present
Graduate Admissions Committee
1997–1998, 2008, 2013
Facilities Committee
1997–1998
Honesty Committee
1993–1994
Eta Kappa Nu Faculty Advisor
1991–1996

June 10, 2023