

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SDI Technologies, Inc.
Petitioner

v.

Bose Corporation
Patent Owner

Case IPR2014-00346
Patent 8,364,295

DECLARATION OF DR. ROBERT L. STEVENSON

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I. BACKGROUND AND EXPERIENCE

1. My name is Robert Louis Stevenson. I understand that the Patent Trial and Appeal Board (“Board”) issued a decision (“Decision”) instituting trial with respect to claims 25, 26, 51-53, 55-62, 75, and 76 of U.S. Patent No. 8,364,295 (“the ’295 patent”) based on an Amended Petition requesting *inter partes* review filed by SDI Technologies, Inc. I have been retained in this matter by Fish & Richardson P.C. to provide various opinions regarding that Petition and the Board’s Decision.

2. Some of the issues in this proceeding are the same as those at issue in IPR2013-00465 concerning the ’295 patent. Accordingly, some of the opinions I offer below are substantially the same as the declaration I submitted in IPR2013-00465, including ¶¶ 3-16, 19-22, 24, 26, 40-54, and 63.

3. I earned my Ph.D. (1990) from Purdue University in Electrical Engineering and earned my B.S. degree (1986) in Electrical Engineering from the University of Delaware. My Ph.D. research related to communications and signal processing.

4. I am presently a Professor in the Department of Electrical Engineering and in the Department of Computer Science and Engineering at the University of Notre Dame. I have served concurrently as a Professor in the Department of Computer Science and Engineering at the University of Notre Dame since January

2003. I first joined the faculty at the University of Notre Dame as an Assistant Professor in the Department of Electrical Engineering in 1990. In August 1996, I received tenure and became an Associate Professor and in August 2002, I became a Professor in the Department of Electrical Engineering. I continue to serve in that capacity.

5. Since 2013 I have served as an Associate Chair of the Department of Electrical Engineering. I also serve as the Director of Undergraduate Studies in Electrical Engineering. In this role I oversee the department's undergraduate program in Electrical Engineering.

6. I spent the summer of 1992 at the Air Force Research Lab in Rome, New York and I spent the summer of 1993 at the Intel® Corporation in Hillsboro, Oregon. 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 100 technical papers related to the field of digital signal processing and digital systems.

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

8. For the past 20 years my work has focused on the design of techniques, hardware, and software for the processing of digital signals using digital computing devices. These technologies are at the foundation of all modern audio systems. As an academic researcher I attempt to develop novel ideas for systems, then publish and present those ideas to the technical community. My success as an academic is directly related to the insights and techniques that provide the basis for new generations of products. My early work on digital techniques for printing and image capture devices led to significant interaction with companies developing desktop computer products in the early 1990's as they tried to incorporate those ideas into their products.

9. My interaction with Apple's Imaging Group focused on various imaging devices such as digital cameras, scanners, and printers and how to best support those devices on desktop computers. At Intel, I worked in Intel's Architecture Lab at the time the MMX multimedia instructions were being incorporated into the Pentium processor. My work there dealt with developing compression techniques for CD-ROM's and network communications that were well matched to the Pentium architecture. I also gave a series of talks on how advanced communication and signal processing techniques could be better supported on the Pentium platform. Similarly, my interaction with Sun Microsystem's group examined how advanced signal processing techniques could

be best implemented using Sun's new Visual Instruction Set on the Sparc architecture.

10. I have also received significant support for my research from several U.S. Department of Defense Agencies. The Air Force Research Laboratory has funded my work to develop advanced parallel processing algorithms that exploited an ad-hoc network of mixed computers to achieve significant computational advantages over their previously implemented techniques. Other Department of Defense agencies have supported my work in image and video enhancement.

11. Over the past 23 years I have taught numerous courses at both the undergraduate and graduate levels in circuits, electronics, digital signal processing, random processes and image processing. Last semester I taught "Advanced Digital Signal Processing" to first year graduate students in Electrical Engineering. The course focused on digital systems and their implementation for digital signals such as audio signals. I have taught this material numerous times over the past 23 years to both graduate and undergraduate Electrical Engineering students. This semester I am teaching "Multimedia Signal and Systems" to 3rd and 4th year undergraduate students. The course focuses on multimedia signals such as MP3 music files and the systems that are designed for the capture, storage and playback. I first introduced and developed this course in 2012 and it has since become a foundational course in a Multimedia concentration at Notre Dame.

12. In the course of my teaching experience, I have both participated in and supervised students in completing a number of projects related to audio systems. These projects include design of a set of 5.1 channel speakers (twice), design of digital filters for detecting the spectral content of audio signals (several times), and design of special audio effects, such as echo and room enhancement effects.

13. I have published over 150 papers in international journals and international conferences.

14. I am an inventor of U.S. Patent No. 6,081,552, "Video Coding Using a Maximum A Posteriori Loop Filter," June 27, 2000.

15. My Curriculum Vitae is attached to this declaration as Appendix A.

II. INDEPENDENT EXPERT

16. I am being compensated at my usual rate of \$600/hour for each hour of work in connection with this matter. My compensation is not contingent on any of the opinions I provide or the outcome of this matter.

III. MATERIALS CONSIDERED

17. I have reviewed the '295 patent and its prosecution history, SDI's Amended Petition with respect to Ground I, and the exhibits relating to that ground, Bose's Preliminary Response, the Board's Decision instituting trial and

cited exhibits, the final deposition transcript of Dr. Lippman's March 10, 2014 deposition and the exhibits thereto, and the additional materials set forth below.

18. In addition to my own background and experience, I have relied on the following additional materials:

Patent Owner Exhibit Number	Exhibit Description
Ex. 2105	Operating Instructions for RM-AV2000 Integrated Remote Commander by Sony Corporation (1997)
Ex. 2106	U.S. Patent 5,644,303, titled "Specialized Shaped Universal Remote Commander"
Ex. 2107	U.S. Patent 5,872,562, titled "Universal Remote Control Transmitter With Simplified Device Identification"
Ex. 2109	U.S. Patent No. 8,401,682 (sister patent to the '295 patent)
Ex. 2110	U.S. Patent No. 7,277,765 (parent patent to the '295 patent)
Ex. 2115	Excerpts of File History for U.S. Patent No. 7,277,765 (parent patent to the '295 patent)
Ex. 2116	Excerpts of File History for the '295 patent

IV. APPLICABLE STANDARDS

19. I understand that the disclosure and claims of a patent are read and understood from the perspective of a hypothetical person of ordinary skill in the art to which the patent is directed at the time of the invention ("POSITA"). For my analysis, I have been told to assume that the relevant timeframe is October 12, 2000, which is the date that the earliest patent application that led to the '295

patent was filed in the Patent Office. I understand that the Patent Owner may claim an earlier invention date.

20. It is my understanding that a POSITA is not a genius or expert in the art at hand, and is not necessarily represented by the skill, education, or experience of the inventor. I also understand that this person of ordinary skill in the art has common sense and only ordinary creativity, and is not an automaton.

21. I believe a person having the level of ordinary skill in the relevant art at the relevant time frame would have a combination of experience and education in the design and development of audio systems, typically a Bachelor of Science degree in electrical engineering or similar field plus at least three years of experience in designing, implementing, testing, teaching, or otherwise working with audio systems.

22. Based on my background and experience, I have a good understanding of the capabilities of a person of ordinary skill in the relevant field and am at least a person of ordinary skill in the art. I have also worked closely with and taught many such persons over the course of my career.

23. I understand that the challenged claims are given their broadest reasonable interpretation that is consistent with the patent specification. I understand that the Board has made some preliminary constructions of certain terms in the challenged claims. In forming the below opinions, I have applied the

Board's constructions except where specifically noted otherwise. For example, as noted below, I was asked to apply and did apply Bose's proposed construction of "configured to respond to signals received from the computer."

24. It is my understanding that, when assessing whether a claim is obvious based on a combination of prior art references, the correct vantage point is from that of a person of ordinary skill in the art at the time the invention was made. I further understand that portions of a prior art reference should not be taken out of context and relied upon with the benefit of hindsight to show obviousness. Rather, a reference should be considered in its entirety, and portions arguing against or teaching away from the claimed invention must be considered. I also understand that a prior art reference teaches away when a person of ordinary skill, upon reading the reference, would be led in a direction divergent from the path that was taken by the inventors of the patent. I further understand that a claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. I also understand that a claim composed of several elements is not proved obvious merely because it is possible, or feasible, for a person of ordinary skill in the art to combine the elements. I understand that it is impermissible to use the patent as a roadmap to reconstruct the invention from the prior art using the benefit of hindsight. Thus, while I understand that there need not be a specific teaching or suggestion present in the

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

V. '295 PATENT

25. The '295 patent includes six independent claims. Independent claims 1, 27, 53, and 59 are implicated in this proceeding either directly or because one of its dependent claims is at issue. Each of these claims relate to an audio system configured to connect to a computer. One example of a computer that is configured to connect to the audio system of claims 1, 27, and 59 is a desktop personal computer (PC). Another example is a mobile computer, such as a smartphone.

26. The audio system includes a sound reproduction device and a remote control. The remote control is configured to transmit at least two types of commands from a user to the sound reproduction device. The first type of command controls a user function of the sound reproduction device (e.g., speaker volume), while the second type of command controls a user function of the computer relating to control of audio information (e.g., selecting and playing a music file). In response to the remote control transmitting the second type of command to the sound reproduction device, control circuitry included in the sound

reproduction device transmits a signal to the computer for controlling the designated user function of the computer. The sound reproduction device also includes an amplifier for powering speakers.

VI. “CONFIGURED TO RESPOND TO SIGNALS RECEIVED FROM THE COMPUTER”

27. I have been asked to consider what a person of ordinary skill in the art would have understood the sound reproduction device being “configured to respond to signals received from the computer” to mean in the context of the ’295 patent at the relevant time. Based on the positions SDI has taken in its Amended Petition (which I describe more fully below), I understand SDI interprets this requirement to mean that the sound reproduction device is configured to simply take any action as a result of signals received from the computer. For example, SDI contends that if a sound reproduction device is configured to turn on as a result of audio signals being sent to it from the computer, then that is sufficient to meet this limitation. *E.g.*, Amended Petition at 11. In addition, in its Decision, the Board tentatively adopted the construction of “configured to respond to signals received from the computer” as “configured to take an action as a result of signals received from the computer.” Decision at 10. In my opinion, SDI’s interpretation of the phrase, and the Board’s tentative construction of the phrase, are not correct in the context of the ’295 patent. Rather, a person of ordinary skill would have understood the broadest reasonable construction of “configured to respond to

signals received from the computer” consistent with the specification to mean that the sound reproduction device is “configured to answer or reply to the computer, *i.e.*, send a responsive communication back to the computer.”

28. I note the specification of the ’295 patent only uses the word “respond” in one passage, where “respond” is used to mean an answer or reply. In that passage, the specification describes an embodiment where a control signal is sent from the sound reproduction device to the computer system, and then the sound reproduction device determines that the computer system is in a responsive state “if the computer system *responds* to the control signal.” Ex. 1001 at 1:6-2:2 (emphasis added). In this example, in order for the sound reproduction device to know that the computer system is in a responsive state, the computer system would have to send an answer or reply back to the sound reproduction device telling it so. If the computer simply took some action as a result of receiving the control signal (e.g., if the computer merely turned on) but did not send an answer or reply back to the sound reproduction device, the sound reproduction device would conclude that the computer is in an unresponsive state, even if that were not true.

29. Although in the challenged claims it is the sound reproduction device that is “configured to respond to signals received from the computer,” the passage at 1:60-2:2 nevertheless teaches what the patent means when it says that one device

“responds” to another device, and shows that the term “respond” is used to mean a responsive communication, such as an answer or reply.

30. The '295 patent also describes an embodiment where the sound reproduction device meets the limitation of being “configured to respond to signals received from the computer” by sending an answer or reply. Figure 7 of the '295 patent shows “a flow diagram for assigning broadcast radio frequencies to the preset buttons according to the invention.” *Id.* at 3:20-21.

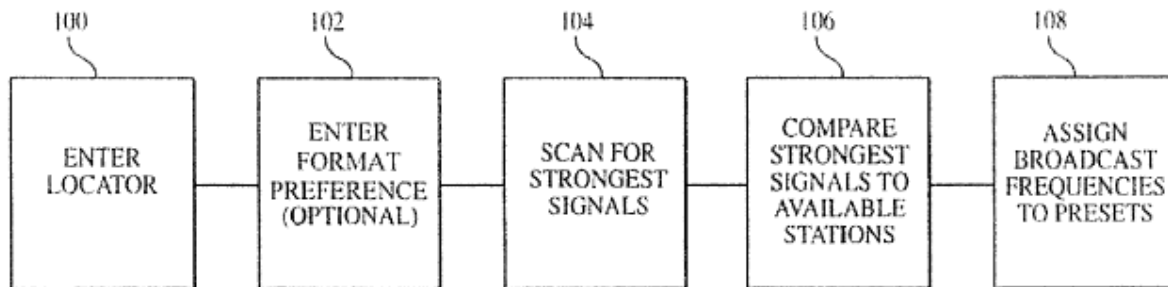


FIG. 7

31. Note that the steps shown in Fig. 7 are performed by the computer system, not the sound reproduction device. *See id.* at 9:22-25 (“Referring to FIG. 7, there is shown a flow diagram of a process for automatically initial preset assignment by a computer program running on computer system 20.”). At step 104, the computer system sends a signal to the sound reproduction device that “directs AM/FM tuner 12 [of the sound reproduction device] to scan the applicable broadcast frequency band for strong signals.” *Id.* at 9:25-28. At steps 106 and

108, the computer then uses information about the “strongest signals” received from the sound reproduction device to assign radio presets. *Id.* at 9:32-39. Thus, in this example the sound reproduction device sends an answer or reply back to the computer with information about the strongest signals available to AM/FM tuner 12.

32. I also note that the specification explicitly describes bidirectional signal paths that would enable such an answer or reply by the sound reproduction device to the computer. *See* Ex. 1001, 4:16-30 (describing interconnections between the computer 20 and the sound reproduction device 10 with respect to Figure 3).

33. Furthermore, I understand that generally, when reading patent claims, there is a presumption that dependent claims are narrower than the independent claims from which they depend, otherwise the dependent claim and independent claim would cover the same subject matter. I understand that this presumption is commonly called “claim differentiation.”¹ However, under SDI’s position and the Board’s tentative construction, dependent claims 25 and 51 of the ’295 patent would be no narrower than the independent claims from which they depend

¹ I also understand that claim differentiation is not a “rigid rule” and that it can be overcome by contrary evidence in the patent’s specification and file history.

(claims 1 and 27, respectively). For example, as discussed more fully below, SDI asserts that the ADA310W speaker system is “configured to respond to signals received from the computer” because it turns on automatically when it receives audio from the computer. Amended Petition at 11, 15, 19, 22, 25. Thus, SDI asserts the alleged sound reproduction device is “configured to respond to signals received from the computer” if it is configured to take an action as a result of audio signals received from the computer. Under this interpretation of “configured to respond to signals received from the computer,” challenged claims 25 and 51 are not narrower than the independent claims from which they depend, because independent claims 1 and 27 already require that the sound reproduction device take an action as a result of audio signals received from the computer.

Specifically, each of these claims require “one or more speakers located at least partially within the housing” and “an amplifier located within the housing for powering the one or more speakers.” Accordingly, independent claims 1 and 27 already require that the sound reproduction device is configured to take some action as a result of receiving signals from the computer—i.e., playing audio.

Indeed, because the main purpose of the invention recited in claims 1 and 27 is to provide a system that is configured to play audio sent from the computer, it meets SDI’s and the Board’s broad construction of “configured to respond to signals received from the computer.” Because the dependent claims presumably do not

correspond to a configuration that recites the basic purpose of the invention as already reflected in the independent claims, I do not believe that SDI's and the Board's construction of "configured to respond to signals received from the computer" is correct. Although I understand that claim differentiation can be overcome by contrary evidence in the specification and file history, I see no such contrary evidence in the '295 patent specification or file history.

34. SDI's and the Board's proposed construction is also inconsistent with the different usage of "respond" and "in response to" in the '295 patent and its related patents. I understand that generally, there is a presumption that different terms used in a patent have different meanings. In that regard, I also note that the '295 patent and its related patents (the '682 patent and U.S. Patent No. 7,277,765) consistently use the term "***respond***" and "***in response to***" to convey different actions. As discussed above, the only use of "respond" in the specification refers to an answer or reply. *See* Ex. 1001 at 1:60-2:2. In contrast, when the '295 patent and its related patents describe taking responsive action (*i.e.*, taking some action as a result of receiving a signal), they consistently use the phrase "in response to." For example, claim 1 of the '295 patent describes actions the sound reproduction device is configured to take "in response to" receiving signals from a remote control. Ex. 1001 at claim 1; *see also* Ex. 1001 claims 27, 53, 59, 63 (same). Claims of the related '682 patent include similar requirements. *See* Ex. 2109 at

claims 1, 28, 55, and 62. Likewise, claim 63 of the '295 patent recites a “display for displaying a user interface configured to present a first assemblage . . . and, *in response to* a user selection of a group in the first assemblage, present a second assemblage of the music files in the selected group” Ex. 1001 at claim 63 (emphasis added); *see also id.* claim 78. Claims of the related '682 and '765 patents include similar requirements. *See* Ex. 2109 at claim 62; Ex. 2110 ('765 patent) at claim 1, 35, 37; *see also* Ex. 2110 at claim 3 (describing instructions to perform an action “in response to” detection of a new music file), 25 (same).

35. In addition, the prosecution history also supports a distinction between “respond” and “in response to.” I understand that generally, prosecution history from related patents is relevant where it concerns the same terms as the patent at issue. Here, claim 18 of the original patent application (leading to the parent '765 patent) used “respond” to mean an answer or reply. For example, claim 18 of the original patent application provided:

18. In an audio system comprising a computer system and a sound reproduction system ... transmitting a control signal from said sound reproduction system to said computer system; and if said computer system responds to said control signal, determining by said sound reproduction device that said computer system is in a responsive state; and if said computer system does not respond to said control signal,

determining by said sound reproduction device that said computer system is in an unresponsive state.

36. Ex. 2115 ('795 File History), pp. 34-35. Thus, this original claim 18 used “respond” to mean an answer or reply that the computer system would send (or would fail to send) to the sound reproduction device.

37. In contrast, in numerous other instances during prosecution of the '765 and '295 patents, both Bose and the Examiner consistently used the “in response to” terminology when discussing a responsive action. Ex. 2115 ('765 File History), pp. 46-48 (new claims 80, 92, 93, 94 and 102), 52-55, 66-69 (new claims 117, 122 and 124); Ex. 2116 ('295 File History), 3-4 (new claim 68), pp. 13-27 (new claims 143, 169, 195, 203 and 209), 47-49 (new claim 226). Thus, in my view the prosecution history also supports the conclusion that “respond” and “in response to” have distinct meanings in the context of the '295 patent.

38. For the foregoing reasons, it is my opinion that a person of ordinary skill in the art at the relevant time, in view of the intrinsic evidence in the '295 patent and its related patents, would have understood the requirement that the sound reproduction device is “configured to respond to signals received from the computer” to mean that the sound reproduction device is “configured to answer or reply to the computer, *i.e.*, send a responsive communication back to the computer,” instead of SDI’s and the Board’s construction.

VII. ANALYSIS OF GROUND I IN AMENDED PETITION

39. Based on the Board's Decision, I understand that it instituted trial with respect to Ground I in the Amended Petition in so far as Ground I asserts that claims 25, 26, 51-53, 55-62, 75, and 76 of the '295 patent would have been obvious over WinAmp, IRMan Web Pages, and the Altec Lansing Manual at the relevant time period. Decision at 10-15.

40. Winamp is described in pages 63-95 of a book by Guy Hart-Davis and Rhonda Holmes entitled "MP3! I Didn't Know You Could Do That." Ex. 1009 at 63-65. Winamp is a software program (for installation on a personal computer) that can be used to play digital audio files. *Id.* at 12. Winamp includes a graphical user interface (GUI) that allows users to play, pause, stop, skip to the next track, and access other features such as graphic equalization, shuffle, and repeat. *Id.* at 18. The Winamp GUI also includes a display area that displays the song title and other information such as the bitrate and frequency of the digital audio file. *Id.* Winamp also allows the user to create and sort playlists of audio files. *Id.* at 22.

41. The IRMan is described in a series of three webpages ("index.html", "faq.html", and "countries.html"), which were attached as Ex. 1010 to SDI's Amended Petition.

42. According to these webpages, the IRMan is a small infrared receiver device that connects to a personal computer via a serial cable and allows the user to

use a remote to control certain software programs on the personal computer. Ex. 1010 at 1, 5. The IRMan webpages make clear that the IRMan product did not come with a remote control. Ex. 1010 at 1. Rather, the IRMan allows the user to use an existing remote control, such as the user's TV, VCR, CD, or Stereo remote control (as long as the remote control is compatible with the IRMan). Ex. 1010 at 1, 4. The IRMan can control Winamp using an additional software component called a "plugin" that the user installs in conjunction with Winamp. Ex. 1010 at 1.

43. The Altec Lansing ADA310W is a computer speaker system composed of two satellite speakers and a subwoofer. Ex. 1011 at 3. The ADA310W receives analog audio from the computer via the audio line output of the computer's sound card (or, alternately if the computer has a specialized 3D Game soundcard, from the "CH1" and "CH2" outputs of the 3D Game soundcard). *Id.* at 4-5. The ADA310W can also connect to the computer's USB port, which allows the user to control all of the functions of the ADA310W from the computer using the supplied Audio Management Software. *Id.* at 3. The ADA310W includes an infrared receiver in the right satellite speaker, which allows the user to control functions of the ADA310W using a remote control. *Id.* at 6.

44. I note that page 7 of Ex. 1011 includes a picture of a remote control with 10 buttons, as well as a description of the associated function and operation for each button. *Id.* at 7. However, statements included on page 7 of Ex. 1011

indicate that the remote control pictured and described is not the remote control for the ADA310W but, rather, is the remote control for an Altec Lansing ADA104 product, which is a different speaker system. For example, in describing the ON/OFF key, page 7 states that the associated operation is “Turns the ADA104 unit on and off.” *Id.* But the ADA310W speaker does not have a power switch. Ex. 1011 at 4, 5. In addition, page 6 of the ADA310W manual describes that the remote control includes functionality for selecting four different operating modes of the system: Stereo, Dolby Pro Logic, Dolby Digital, and 3D Gaming. Ex. 1011 at 3. But the remote control depicted on page 7 (for the ADA104 product) does not show any button for selecting the Dolby Digital operating mode.

45. One of ordinary skill seeking to combine the IRMan and ADA310W would have been directed by the express teachings of the references to make the combination in one of two ways: either (1) by connecting both the IRMan infrared receiver and ADA310W speaker system to the personal computer and modifying the ADA310W software to receive commands from the IRMan and forward them to the ADA310W, or (2) by connecting both the IRMan infrared receiver and ADA310W speaker system to the personal computer and using a standard universal remote control to control both the Winamp software (via the IRMan) and the ADA310W software.

46. The first configuration expressly taught by the references is one where all remote control commands are sent to the personal computer via the IRMan infrared receiver. In this combination, the IRMan is connected to the serial port of the personal computer, and one uses a standard remote control (such as one for a CD player) to send commands to the personal computer via the IRMan.² EX 1010 at 1.

47. The IRMan reference expressly teaches that a user can program support for IRMan in other software applications (besides Winamp), so that IRMan can be used to control features of those applications. Ex. 1010 at 4. In fact, users are encouraged to use IRMan to control other software applications, and the company that developed IRMan (Evation.com) offers support and sample source code to that end. *Id.* In addition, the ADA310W speaker system comes with Audio Management Software that can send commands over the personal computer's USB port to control the functions of the ADA310W from the personal computer. Ex. 1011 at 3.

² Note that a universal remote control such as the Sony Remote Commander could also be used in this combination, but a universal remote control is not required.

48. Using these teachings of IRMan and the ADA310W, one of ordinary skill would simply program support for the IRMan in the ADA310W Audio Management Software, so that the Audio Management Software receives remote control commands via the IRMan and sends commands over the USB port to control corresponding functions of the ADA310W. One would assign certain buttons of the remote control to control the features of the ADA310W and would configure the Winamp plugin to assign other buttons on the remote control (such as play, pause, forward, and reverse) to control the features of Winamp via the IRMan. In this configuration, the user would have a single remote control that controls functions of both the ADA310W software and the Winamp software, by sending commands to a single IR receiver coupled to the computer. This configuration would not meet the requirements of the claims challenged in Ground I of the Amended Petition, because the claims all require the remote control to be configured to interact with control circuitry in the sound reproduction device, not the computer.

49. This first configuration is expressly taught by the references, uses a single remote to control both the ADA310W and Winamp, and requires no hardware modifications to the IRMan, the ADA310W, or the personal computer. Furthermore, as both a single remote control and a single IR receiver is used, this

configuration satisfies SDI's purported motivation of reducing "clutter and duplication."

50. The second configuration expressly taught by the references is using a universal remote control to control both the Winamp software (via the IRMan IR receiver) and the ADA310W speaker system through its own IR receiver. For example, one of the IRMan web pages states that "Irman has built in support for almost every ir remote standard" and that "the vast majority of remotes" are compatible with IRMan. Ex. 1010 at 4. A person of ordinary skill at the relevant timeframe would have understood that one type of such a remote control is a universal remote control. Indeed, using a single universal remote control to send commands to multiple devices, such as a television and DVD player, was a well-known solution if one wanted to eliminate the need to use multiple remote controls. *See, e.g.*, Ex. 2105 (describing the Sony RM-AV2000 Integrated Remote Commander); Ex. 2106 (U.S. Patent No. 5,644,303, describing a "Specialized shaped universal remote commander"), Ex. 2107 (U.S. Patent No. 5,872,562, describing a "Universal remote control transmitter with simplified device identification").

51. The Sony RM-AV2000 Integrated Remote Commander (the "Sony Remote Commander") is an example of such a universal remote control. *See* Ex. 2105. The Sony Remote Commander is described in a user manual entitled

“Integrated Remote Commander Operating Instructions,” RM-AV2000, copyright 1997 by Sony Corp. *Id.* at 1. The user manual states that “[t]he RM-AV2000 Remote Commander provides centralized control of all your AV components from a single remote commander and saves the trouble of operating different AV components with different remote control devices.” *Id.* at 3. The Sony Remote Commander includes a number of separate, physical buttons (such as CHANNEL + and -, and VOLUME + and -). Ex. 2105 at 7. The Sony Remote Commander also includes a number of touch keys displayed and selectable via an “LCD touch key display.” *Id.*

52. The Sony Remote Commander can be programmed to control non-Sony components using built-in component codes for a number of other manufacturers’ remote controls. *Id.* at 8-9. Alternatively, one can use the “learning” procedure to “teach” any of the programmable buttons and keys of the Sony Remote Commander to operate the functions of another remote control. *Id.* at 13-15. For example, Sony Remote Commander can “learn” the volume commands from another remote control, so that the Sony Remote Commander’s volume keys can be used to control the volume of another AV component (such as a stereo system). *Id.* This is done using the procedures described in the user manual, which involves pointing the other remote control at the Sony Remote

Commander, pressing the button on the Sony Remote Commander you want to teach, and pressing the corresponding button on the other remote control. *Id.*

53. The IRMan, ADA310W, and Sony Remote Commander references teach a person of ordinary skill to make the following combinations. The IRMan infrared receiver is connected to the serial port of the personal computer, and the ADA310W speaker system is connected to the USB port of the personal computer. Ex. 1010 at 1, 5; Ex. 1011 at 3. The “learning” function of the Sony Remote Commander is used to “learn” the remote control functions of the ADA310W remote control and assign them to buttons on the Sony Remote Commander. Ex. 2105 at 13-15. The Sony Remote Commander can then be used to control all of the functions of the ADA310W via the ADA310W’s IR receiver. The user would then configure the Winamp plugin to assign remaining buttons on the Sony remote control (such as play, pause, forward, and reverse) to control features of the Winamp software via the IRMan infrared receiver. IRMan specifically teaches that Sony remote controls can be used with the IRMan. Ex. 1010 at 5. In this configuration, the user would have a single remote (the Sony Remote Commander) that controls functions of both the ADA310W and Winamp. This configuration would also not meet the requirements of the claims challenged in Ground I of the Amended Petition, because the claims all require the sound reproduction device to be configured to transmit a signal to the computer for controlling a user function of

the computer when the user issues such a command, which would not be performed in this configuration.

54. This second configuration is expressly taught by the references, uses a single remote to control both the ADA310W and Winamp, and requires no software or hardware modifications to the IRMan, the ADA310W, or the personal computer. Furthermore, as a single remote control is used, this configuration also satisfies SDI's purported motivation of reducing "clutter and duplication."

55. Furthermore, in my opinion SDI has not shown the combination of the ADA310W, Winamp, and the IRMan would render obvious the requirement of a sound reproduction device "configured to respond to signals received from the computer" as recited in challenged claims 25 and 51 of the '295 patent. As discussed above, it is my opinion that a person of ordinary skill would understand the phrase "configured to respond to signals received from the computer" in the context of the '295 patent to mean that the sound reproduction device is "configured to answer or reply to the computer, *i.e.*, send a responsive communication back to the computer." None of the references on which SDI relies disclose such an answer or reply.

56. In its analysis for claims 25 and 51 with respect to Ground I, SDI states:

The speakers were configured to respond to signals received from the computer.

“Computers that are USB (universal serial bus) equipped can control all speaker functions from the desktop.” (ADA310 Manual, Ex. 1011, at 3.) This is done with software that runs on the computer, using a graphic user interface. (*Id.*) The control necessarily would be accomplished by electrical signals to which the speaker would respond.

In addition, the ADA310 speaker did not have a power switch but, instead, “[w]hen audio is received . . . the speaker turns on automatically.” (*Id.*, at 4.) Thus, the speaker also responded to music signals from the computer.

Amended Petition at 19, 22.

57. Accordingly, SDI relies on two passages of the ADA310W manual (Ex. 1011) for disclosure of the “configured to respond to the signals received from the computer” requirement. First, SDI relies on the description in the ADA310W manual that a desktop computer can control “all speaker functions” of the ADA310W via a USB connection. Ex. 1011 at 3. However, at most this passage shows that the desktop computer sends a signal to the ADA310W speaker system to control a speaker function (*e.g.*, volume), and then upon receiving that signal the ADA310W then takes an action (*e.g.*, adjusting volume). Nothing in this passage discloses that the ADA310W speaker system ever sends an answer or reply (*i.e.*, a responsive communication) back to desktop computer. Second, SDI relies on the description in the ADA310W manual that the ADA310W speaker system “turns on automatically” when audio is received, for example, from the desktop computer.

Id. at 4. However, at most this second passage shows that the ADA310W takes an action (*i.e.*, turns on) upon receiving audio from the desktop computer. Nothing in this second passage discloses that the ADA310W ever sends an answer or reply (*i.e.*, a responsive communication) back to desktop computer. Accordingly, neither passage on which SDI relies for challenged claims 25 and 51 of the '295 patent shows that the alleged sound reproduction device is "configured to answer or reply to the computer, *i.e.*, send a responsive communication back to the computer."

58. In addition, all challenged claims of the '295 patent require that the sound reproduction device includes "a housing," and that the sound reproduction device also includes "control circuitry located within the housing" and "a connector located at least partially within the housing that is configured to provide a physical and electrical connection exclusively between the sound reproduction device and the computer." *See* Ex. 1001 ('295 patent) at claim 1 (from which challenged claims 25 and 26 depend); claim 27 (from which challenged claims 51 and 52 depend), claim 53 (from which challenged claims 55-58 and 75 depend), claim 59 (from which challenged claims 60-62 and 76 depend). Thus, the challenged claims require a "connector" located at least partially within the same housing in which the "control circuitry" is located. In my opinion SDI has not shown these requirements are met by the combination of the ADA310W, Winamp, and the IRMan.

59. For the alleged “control circuitry located within the housing,” SDI points to the “IR receiver” of the ADA310W. Amended Petition at 17, 20, 24, 29. According to the ADA310W manual, the IR receiver of the ADA310W is located within the *right satellite speaker* of the ADA310W. See Ex. 1011 at 6 (Fig. 2, showing “RIGHT SPEAKER” with “IR RECEIVER”). For the alleged “connector,” SDI points to the “connections for the speaker audio” that according to SDI “would have . . . provid[ed] a physical and electrical connection exclusively between the speaker and the computer.” Amended Petition at 17, 20, 24. The ADA310W manual describes that these connections (*i.e.*, “connections for the speaker audio”) would be made with the *subwoofer* of the ADA310W. Ex. 1011 at 4-5 (showing and describing “STEREO IN,” “CH1,” and “CH2” audio inputs located on the subwoofer). Thus, for the “connector” claim requirement, SDI points to a component of the ADA310W subwoofer.

60. Accordingly, SDI points to alleged “control circuitry” located within one housing (the right satellite speaker), but an alleged “connector” within a different housing (the subwoofer). This does not meet the requirement of “control circuitry located within the housing” and “an connector located at least partially within the housing that is configured to provide a physical and electrical connection exclusively between the sound reproduction device and the computer,” as all the challenged claims require.

VIII. AMPLIFIER IN THE '295 PATENT

61. Each of the challenged claims of the '295 patent recites that the sound reproduction device includes a “housing,” “an amplifier located within the housing . . .,” and “control circuitry located within the housing.” *See* Ex. 1001 ('295 patent) at claim 1 (from which challenged claims 25 and 26 depend); claim 27 (from which challenged claims 51 and 52 depend), claim 53 (from which challenged claims 55-58 and 75 depend), claim 59 (from which challenged claims 60-62 and 76 depend). Thus, each of the challenged claims of the '295 patent requires an amplifier located within the same housing as the control circuitry. I disagree that SDI has shown that the ADA310W includes an amplifier located within the same housing as the control circuitry.

62. For the alleged “control circuitry located within the housing,” SDI points to the “IR receiver” of the ADA310W. Amended Petition at 17, 20, 24, 29. According to the ADA310W manual, the IR receiver of the ADA310W is located within the *right satellite speaker* of the ADA310W. *See* Ex. 1011 at 6 (Fig. 2, showing “RIGHT SPEAKER” with “IR RECEIVER”).

63. SDI asserts in its Amended Petition that each of the three speakers of the ADA310W included an amplifier. Amended Petition at 16 (“The speakers had amplifiers located within the housing, 10W in the small speakers and 24W in the subwoofer. (See ADA Manual, Ex. 1011, at 7 (5W per driver in the satellites).)”),

20 (same), 23 (same), 28 (same). Because the claims require the amplifier to be within the same housing as the control circuitry, SDI's Amended Petition can only be read to mean that in view of the manual's reference to the a speakers' power rating, there is an amplifier in the right satellite speaker. (SDI points to the IR receiver in the ADA310W as part of the control circuitry, *see* Amended Petition at 17, and this IR receiver is located within the right satellite speaker, *see* Ex. 1011 at 6). A person of ordinary skill at the relevant time period would understand that these numbers on page 7 of the ADA310W manual are simply power ratings that indicate the maximum power the speaker drivers are designed to output in the ADA310W system; they do not indicate where any amplifier circuitry is located. Such a person would understand that the amplifier for the speaker drivers need not be in the same housing as the drivers themselves. And SDI presents no evidence regarding where the amplifiers are located within the three separate housings that comprise the ADA310W system.

I declare that all statements made in this declaration are of my own knowledge and are true and that all statements made on information and belief are believed to be true; 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.

Signed: September 16, 2014

/Robert L. Stevenson/
Robert L. Stevenson

APPENDIX A

Robert Louis Stevenson

Curriculum Vitae

Contact

275 Fitzpatrick Hall
Department of Electrical Engineering
University of Notre Dame
Notre Dame, Indiana 46556

Tel.: +1 574-631-8308
Fax: +1 574-631-4393
EMail: rls@nd.edu

WWW: <http://engineering.nd.edu/profiles/rstevenson>

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–Present	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

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–Present
Visual Communications and Image Processing, 1997–Present
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

Member

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
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Hong Kong Research Grants Council
Kentucky EPSCoR Program

North Dakota EPSCoR Program
Louisiana Board of Regents

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

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Y. Li and **R. L. Stevenson**, “Register multimodal images of range information,” to appear at the *SPIE Conference on Visual Information Processing and Communication V*, San Francisco, CA, February 2014.

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R. Zhen and **R. L. Stevenson**, “Joint Deblurring and Demosaicking of Raw Image Data With Motion Blur” to appear at the *SPIE Conference on Visual Information Processing and Communication V*, San Francisco, CA, February 2014.

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

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

Luke Hollman
Jonathan Simpkins
Ruiwen Zhen

Research Funding

Current Funding

Principal Investigator, EE Chair Fund, \$250,000 for “Video Enhancement Research.”

Prior Funding

Principal Investigator, Jesse H. Jones Faculty Research Fund, Univer-

sity 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 Compressed 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 Compu-

tational 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).

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

EE40354	Multimedia Signals and Systems Developed: Fall 2012 Taught: Fall 2012, 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, Fall 1997, 2001, 2003, 2010
EE598/EE60671	Advanced Digital Signal Processing Developed: Fall 2004 Taught: Fall 2004, 2005, 2011, 2013
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

Club Supervisor, Rubik's Cube Club of Notre Dame
2011–Present

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

Engineering College

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

Committee on Appointments and Promotions
2007–2009
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, 2011–2013

Undergraduate Coordinator
1994–1996, 1998–1999
Undergraduate Mentor
2006–Present
Qualifying Exam Coordinator
1991–1993
Computer Committee, Chair
1994–1996, 1997–2013
Electrical Engineering Commencement Coordinator
2002
Graduate Admissions Committee
1997–1998, 2008, 2013
Facilities Committee
1997–1998
Honesty Committee
1993–1994
Eta Kappa Nu Faculty Advisor
1991–1996

April 1, 2014