

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

Petitioners,

v.

**MAXELL, LTD.,
Patent Owner**

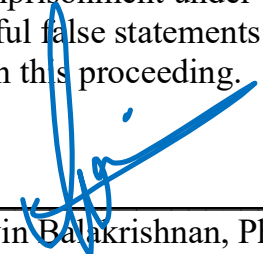
Case: IPR2024-00867

U.S. Patent No. 10,176,848

**DECLARATION OF RAVIN BALAKRISHNAN, PH.D.
CONCERNING PATENTABILITY OF U.S. PATENT NO. 10,176,848**

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine and/or imprisonment under Section 1001 of Title 18 of the United States Code, and such willful false statements may jeopardize the validity of the patent which is under review in this proceeding.

Dated: January 30, 2025



Ravin Balakrishnan, Ph.D.

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I. INTRODUCTION

1. My name is Ravin Balakrishnan. I have been asked by Patent Owner in this IPR (Maxell, Ltd.) to respond to the Declaration of Dr. Benjamin Bederson (the “Bederson Decl.”) and to provide my opinion as to the patentability of U.S. Patent No. 10,176,848 (Ex. 1001, the “’848 Patent”) in view of the opinions in the Bederson Decl.

2. Although I am being compensated at my usual consulting rate of \$750 per hour for my time reviewing materials and preparing this declaration, my opinions expressed here are my own. My compensation is in no way dependent on the outcome of this proceeding or upon the Court or jury accepting my opinions. I have no other financial interest in this matter or the parties thereto.

3. Depending on new information learned during discovery or positions taken throughout the IPR by Samsung or its experts, I may edit, add to, or otherwise refine the topics and expected testimony described here. I reserve the right to supplement my opinions based on new information.

II. BACKGROUND AND QUALIFICATIONS

4. My qualifications to testify about the ’848 Patent and the relevant technology are set forth in my curriculum vitae (“CV”), which I have attached here as Appendix A. My CV includes a list of all my publications within at least the past

ten years. The matters in which I have testified (either at trial or by deposition) in the past four years are also included.

5. I will briefly summarize my qualifications to render opinions regarding this technology in the following paragraphs.

6. I am currently a tenured Full Professor of Computer Science in the Department of Computer Science at the University of Toronto. I joined the faculty at the University in 2001, received tenure in 2006, and served as Chair of my Department from 2015 to 2019. From 2006-2016, I held the Canada Research Chair in Human-Centered Interfaces in the Department of Computer Science.

7. I earned a B.Sc. in Computer Science from the University of New Brunswick in 1993. From the University of Toronto, I received an M.Sc. in Computer Science in 1997 and a Ph.D. in Computer Science in 2001. Since receiving my Ph.D., I have been a member of the faculty of the Department of Computer Science at the University of Toronto where my research has focused on human-computer interaction (“HCI”), interactive computer graphics, and computer systems. Within these areas, my research has included the development of user interface technologies on a variety of computational platforms and application areas including mobile devices, touch input devices, video editing systems, computer vision and image detection/tracking systems, video games, large displays, televisions, 3D displays, and virtual and augmented reality technologies.

8. I am also the co-founder of the following companies: Conceptualiz, a company that develops virtual surgical planning technology; FindSpace (formerly Arcestra and Sketch2Corp), a commercial real estate marketing and interior design platform; and Bump Technologies Inc., which developed a physically realistic desktop user interface system. FindSpace grew out of research conducted in my lab and was acquired by Cougar Group in 2021. Bump Technologies, Inc. also grew out of research conducted in my lab and was acquired by Google in May 2010.

9. I teach and supervise graduate students and postdoctoral fellows in their research work as part of my professorial duties. To date, 27 research M.Sc. students, 16 Ph.D. students, and 9 postdoctoral fellows have completed their research training under my guidance. Their research has led to theses and peer-reviewed publications over a broad range of topics covering interactive computing and user interfaces for multiple applications and technology platforms. Example systems built by my team include a new physics enabled touch computing platform, a video conferencing system using face detection to identify and track multiple participants in meetings to enable dynamic camera positioning and focus, and a large scale interactive display system that used camera based image detection and tracking to handle user interaction by multiple simultaneous users in a room sized environment. I have taught courses covering computing topics, including interactive computing, human-computer interaction, information systems and design, digital design, and computer

architecture, and courses covering various user interface technologies for various platforms.

10. I have published over 140 refereed publications in peer-reviewed journals. I have presented numerous conference abstracts, posters, talks, and demonstrations in my field. My work has been cited more than 21,000 times across a spectrum of high-impact publications, and my current h-index score (from Google Scholar) is 84, which is an indication of the significant impact of my research on scholarly literature in the field of Computer Science.

11. I have received major awards and honors in my field. For example, in 2007, I received an Alfred P. Sloan Research Fellowship. In 2011, I was elected into the Association for Computing Machinery's Computer Human Interaction Academy, which is an honorary group consisting of researchers who have made extensive contributions to the study of HCI and who have led the shaping of the HCI field. The stated criteria for being elected into the Association for Computing Machinery's Computer Human Interaction Academy are: (1) cumulative contributions in the field; (2) impact on the field through development of new research directions and/or innovations; and (3) influence on the work of others. In 2020, I was presented with the Canadian Human Computer Communications Society's Achievement Award, which recognizes researchers who have made a

substantial contribution to the fields of computer graphics, visualization, or human-computer interaction.

12. In addition to my research at the University of Toronto, I have collaborated with researchers at leading institutions worldwide. For example, I have been a visiting professor at Laboratoire de Recherche en Informatique (LRI) at the Université Paris-Sud, France and at INRIA Lille, France. Additionally, I have been a visiting researcher at several industrial laboratories, including: (1) HPLabs, (2) Mitsubishi Electric Research Laboratories (MERL), and (3) Microsoft Research Labs. At those companies, my work generally focused on developing new user interface techniques for a variety of technology platforms. Before becoming a professor, during my MSc and PhD studies, I was concurrently a part-time researcher at Alias|wavefront (now part of Autodesk), a leading developer of 3D graphics software applications. Some of my work at these companies, and at my startup companies, have resulted in software and hardware implementations that were shipped within consumer-level products.

13. I have also served on the organizing and paper-reviewing committees of leading conferences in my field, and I have taken on editorial roles for leading technical journals in fields pertinent to my research. For example, I have been an associate editor of the Association for Computing Machinery (“ACM”) Transactions on Computer-Human Interaction and an associate editor of the IEEE Transactions

on Visualization and Computer Graphics, both peer-reviewed journals. Similarly, I have been the paper's chair for the ACM UIST Symposium on User Interface Software and Technology, and have served multiple times as an associate chair for the ACM CHI Conference on Human-Computer Interaction. Over my career, I have also reviewed hundreds of published and unpublished papers, including many on user interfaces for mobile devices.

14. I am the co-inventor on 20 patents, all in the area of user interfaces, including new techniques and technologies for handling user input to computational platforms in novel and more facile ways.

III. UNDERSTANDING OF LEGAL STANDARDS

15. I am not a lawyer, but I have been informed by Maxell's counsel of the legal principles necessary to my patentability analysis. In this section, I set forth my understanding of these legal principles as they have been explained to me.

16. I understand that a (patentability) validity analysis of a patent claim consists of two steps. The first step is the construction (or interpretation) of any disputed claim terms. The second step is a comparison of the properly construed claims to the prior art.

A. Obviousness

17. I understand that a patent claim can be invalid under 35 U.S.C. § 103 if the claimed subject matter would have been "obvious" to a person of ordinary skill

in the art as of the priority date of the patent based upon one or more prior art references. I understand that an obviousness analysis should consider each of the following so-called “*Graham* factors”: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the pertinent art; and (4) secondary considerations, if any (such as unexpected results, commercial success, longfelt but unsolved needs, failure of others, copying by others, licensing, and skepticism of experts).

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

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

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

21. I also understand that, in determining whether a combination of prior art references renders a claim obvious, it may be helpful to consider whether there is some teaching, suggestion, or motivation to combine the references and a reasonable expectation of success in doing so. I understand, however, that the teaching, suggestion, or motivation to combine inquiry is not required and may not be relied upon in lieu of the obviousness analysis outlined above.

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

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

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

25. I understand that, in order to be used in an obviousness combination, a prior art reference must be “analogous.” I understand that a prior art reference may be analogous if it is in the same field of endeavor as the other references with which it is combined, or if the reference is reasonably pertinent to the solving the problems the inventors of the patent-at-issue sought to solve.

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

27. I understand that obviousness is not established by simply combining previously known elements from the prior art. A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. An invention is unpatentable as obvious if the differences between the patented subject matter and the prior art would have been obvious at the time of invention to a person of ordinary skill in the art.

28. I understand that obviousness of a patent cannot properly be established by mere conclusory statements. Instead, there must be some articulated reasoning

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

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

30. I understand that technical experts may testify to matters like the level of skill in the art at the time of the invention and what a skilled artisan might find obvious in light of the prior art without addressing objective indicia of non-obviousness. However, where an expert purports to testify not just to certain factual components underlying the obviousness inquiry, but to the ultimate question of obviousness, the expert must consider all factors relevant to that ultimate question, including all objective evidence of nonobviousness.

B. Secondary Considerations

31. I understand that one of the so-called *Graham* factors that must be considered in determining obviousness is the existence of any secondary considerations, which tend to show that a patent claim is not obvious. Such secondary considerations of nonobviousness of a patent include (1) long-felt and unmet need in the art that was satisfied by the claimed invention of the patent; (2) failure of others to achieve the results of the claimed invention; (3) commercial success or lack thereof of the products and processes covered by the claimed invention; (4) deliberate copying of the claimed invention by others in the field; (5) taking of licenses under the patent by others; (6) whether the claimed invention was contrary to the accepted wisdom of the prior art; (7) expression of disbelief or skepticism by those skilled in the art upon learning of the claimed invention; (8) unexpected results achieved by the claimed invention; (9) praise of the claimed invention by others skilled in the art; and (10) lack of contemporaneous and independent invention by others.

32. I understand that each of these considerations may form an independent basis for nonobviousness of a patent. I also understand that the fact that another person simultaneously and independently created the same invention claimed in an asserted patent can serve as an indication that the invention was obvious

33. I also have been informed by counsel that there must be a nexus between any such secondary considerations and the claimed invention.

C. Claim Construction

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

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

36. I understand that the PTAB preliminarily determined that none of the claim terms of the '848 Patent require express construction. Institution Decision, at 22.

37. As such, I have applied the ordinary and customary meaning that the terms would have had to a person of ordinary skill in the art at the time of the invention of May 19, 2008 (the '848 Patent's priority date) in view of the patent's

specification. In other words, I have interpreted the remaining terms in accordance with their “plain and ordinary” meaning.

38. I understand that Dr. Bederson purported to interpret the claims according to their plain and ordinary meaning to a POSITA at the time of the invention (May 19, 2008). *See* Ex. 1005, Bederson Decl., ¶ 38. However, as set forth below, clarification of the plain and ordinary meaning of the term “mode” is necessary in light of how Petitioner and Dr. Bederson apply the prior art to the claims of the ’848 Patent.

D. Level of Ordinary Skill in the Art

39. I understand that claims are to be interpreted from the viewpoint of one of ordinary skill in the relevant art. To determine the level of skill that would be “ordinary,” I understand that a person of ordinary skill must generally have the capability of understanding the general principles that are applicable to the pertinent art.

40. In the case of the ’848 Patent, these general principles include the concepts of image recording and reproduction in modern mobile devices (*e.g.*, cell phones, smartphones, tablets, and the like) using, in part, face recognition technology. A person of ordinary skill in the art should be familiar with these principles.

41. In my opinion, “a person of ordinary skill in the art” in the field of the ’848 Patent would have had a working knowledge of image recording and reproduction, and face recognition technology. The person would have gained this knowledge through an undergraduate Bachelor of Science degree in Computer Science or Electrical Engineering or equivalent degree and at least one year of experience working in the field of image recording and reproduction. More education (*e.g.*, a Master’s degree) or work experience in a relevant field may compensate for a deficit in one or the other relevant qualifications stated above. This is based on my review of the ’848 Patent and my knowledge of those who were working in the field at the time of the invention.

42. I understand the PTAB found that a person of ordinary skill in the art would have “a Bachelors’ degree in electrical or computer engineering or a comparable field of study, with at least two to three years of experience in the field of image processing.” Institution Decision, at 20-21. The PTAB also stated that “[a]dditional education could substitute for professional experience, and significant experience in the field could substitute for formal education.” *Id.*

43. I do not believe that my definition of a person of ordinary skill is materially different, and I qualify under the PTAB’s definition or my proposed definition. Accordingly, my opinions here would not change under my or the PTAB’s definition of a POSITA.

IV. MATERIALS CONSIDERED

44. Among the materials I specifically considered at the time I formed my opinions on patentability are the '848 Patent (Exs. 1001, 1002); the '848 Patent's prosecution history (Ex. 1003) including the reexamination history (Ex. 1004) of the '848 Patent; U.S. Patent No. 9,159,368 (the parent patent to the '848 Patent) and its original file history (Application No. 12/430,185); the Bederson Declaration (Ex. 1005) and the materials cited therein; the parties' claim construction briefing; Samsung's Petition for institution of an Inter Partes Review (IPR) of the '848 Patent, matter number IPR2024-00867 ("'848 IPR Petition") and related filings from that matter; the alleged prior art relied upon by Dr. Bederson; and the other materials that I specifically cite to and mention throughout this declaration.

45. In addition to these materials, I relied upon my decades of experience and expertise in computer science and electrical engineering, particularly in system design, video processing, and communications. I have also taken into account the knowledge and background principles that a person of ordinary skill in the art would be familiar with at the time of Patent Owner's invention (no later than May 19, 2008).

V. BACKGROUND OF THE TECHNOLOGY OF THE '848 PATENT

A. Overview of the '848 Patent

46. Before discussing my specific opinions on patentability, I will first review the '848 Patent's disclosures as they would have been viewed by a person of

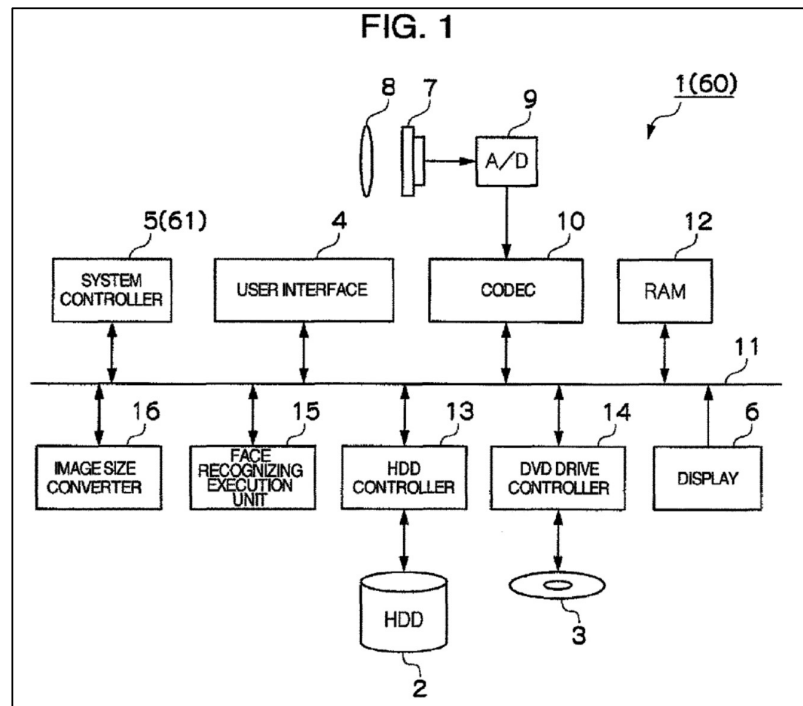
ordinary skill in the art. My discussion describes only certain examples of the inventions discussed in the '848 Patent, and my description here is in no way meant to suggest that the claimed inventions are limited to these examples. The inventions are limited only by the claims.

47. The '848 Patent is entitled "Recording and Reproducing Apparatus and Method Thereof" and was awarded to inventor Mari Yoshida. It was filed on September 5, 2014, is a continuation of U.S. Patent No. 9,159,368 (filed on April 27, 2009) (Ex. 2027) and ultimately claims priority to Japanese Patent Application No. 2008-130678 (Ex. 2026), which was filed on May 19, 2008. The priority date of this patent is no later than this date.

48. I have reviewed U.S. Patent No. 9,159,368 and, apart from the claim language, the disclosure of the '848 and '368 Patents are identical (*i.e.*, same 15 figures, same specification description of the figures). I have also reviewed Japanese Patent Application No. 2008-130678, which has the same (apart from information being in Japanese) 15 figures that are in the '848 and '368 Patents, and the priority chain going back to May 19, 2008, is unbroken.

49. The '848 Patent is directed to a recording and reproducing apparatus that makes it easier for a user to navigate through a large number of recorded images and videos.

50. For example, Figure 1 of the '848 Patent is a block diagram illustrating the structure of a video according to several embodiments:

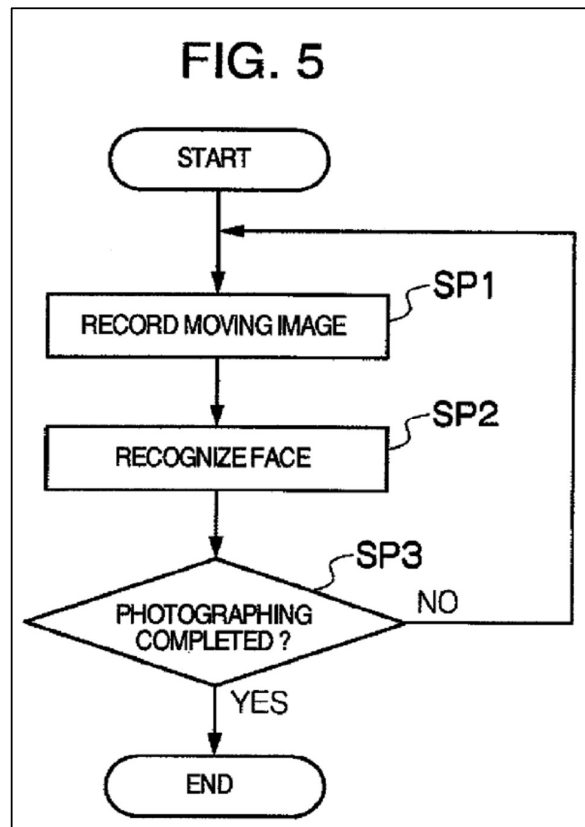


Reproduction of Fig. 1 of the '848 Patent

51. After recording a photographed image, a user can view the image on a user interface such as a liquid crystal display that is part of the video camera, where the image can then be stored on the camera such as in a random access memory (RAM). *See* Ex. 1001, '848 Patent, 3:51-4:24.

52. The '848 Patent then discloses performing a face recognition process on the stored image, which can be used to later register a person's face. *See* Ex. 1001, 4:25-35. Figure 5, reproduced below, is "a flow chart illustrating the sequence

of a photographed image recording process” that also includes a facial recognition step:

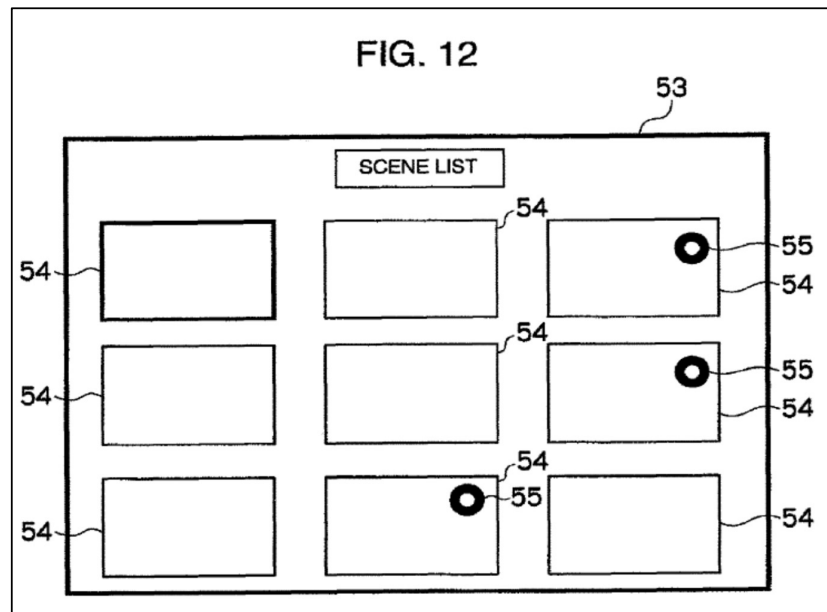


Reproduction of Fig. 5 of the '848 Patent

53. The '848 Patent describes the facial recognition process using, for example, a template matching process using preregistered face recognizing information. *See* Ex. 1001, 6:24-7:21; *see also id.*, 5:47-6:23; Figures 3 and 4.

54. The '848 Patent also describes, in Figure 12, displaying an icon 55 having a predetermined shape on a stored thumbnail image 54 denoting the

importance level of information associated with that thumbnail image. See Ex. 1001, 11:4-35. Figure 12 is reproduced below.



Reproduction of Fig. 12 of the '848 Patent

55. The '848 Patent further describes that the above application is applicable to “mobile phone provided with a moving image photographing function.” Ex. 1001, 13:41-42.

B. Problems the Inventors Set Out to Solve

56. Prior to the inventions disclosed in the '848 Patent, the inventor recognized problems in the field as follows:

In recent years, recording and reproducing apparatus are in widespread use which apparatus are compatible with randomly accessible recording media such as a digital versatile disc (DVD), a semiconductor memory and a hard disc drive (HDD). Such recording and reproducing apparatus can easily and quickly cue a photographed image recorded in a recording medium.

Of recording and reproducing apparatus of this type, for example, a general video camera manages generally video information of photographed images in the unit of scene, and cues each scene by using management information on each scene. A video camera of this type can set a plurality of chapters in one scene, and can cue each chapter.

A scene means a series of images recorded during a period from when a user depresses a record button to start photographing to when the user depresses again the record button to stop photographing. The number of scenes increases each time photographing is made upon depression of the record button. The chapter means a delimiter of images in one scene.

A user of a video camera can know quickly the contents of each scene by reproducing image information recorded in the recording medium by sequentially cuing each chapter.

However, if the number of chapters set in a scene is large, a user of the video camera is required to repeat a cue operation as many times as the number of chapters set in the scene, in order to confirm the contents to the last scene. There arises therefore a problem of much work and long time.

JP-A-06-165009 discloses techniques of efficiently knowing the contents of a scene by calculating a priority order of each frame from the type of button manipulation during photographing, and reproducing a frame having a higher priority order.

The capacity of a recording medium of a recent video camera is becoming large so that a scene photographed in a long time duration can be stored in the recording medium or scenes photographed a plurality of times can be stored in the recording medium. It is therefore difficult for a user to quickly find a target scene from a number of scenes recorded in the recording medium.

Some conventional recording and reproducing apparatus are equipped with a function of displaying a list of thumbnail images of scenes. However, this function displays only one thumbnail image per one scene so that a user feels difficult in some cases to know the whole

contents of a scene photographed in a long time duration from one thumbnail image. Further, after a lapse of long time after photographing, it is difficult for a user to remember the whole contents of a scene from one corresponding thumbnail image.

If a user cannot remember the contents of a scene even if the thumbnail image is viewed, the user confirms the contents of the scene by reproducing the scene. If the contents of a long time scene is to be confirmed, it becomes necessary to provide a function of confirming quickly the whole contents of the scene by cuing each chapter. However, this function has not been proposed yet.

JP-A-06-165009 discloses techniques of calculating a priority order of each frame from the type of button manipulation during photographing, and when digest reproduction for knowing the contents of a scene is to be performed, reproducing a frame having a higher priority order. According to the techniques, however, a priority degree cannot be set to a scene photographed without button manipulation by a user. It cannot be said that the techniques are easy to use.

Ex. 1001, 1:15-51, 1:55-2:17. In sum, prior to the '848 Patent, recording and reproducing apparatuses like smartphones and laptops were being used to record a large number of videos and pictures. In order to make it easier for a user to find recorded content, conventional techniques generated a list of thumbnails corresponding to each recorded content, giving the user a type of "preview" of the recorded content. However, as the volume of recorded content increased it became difficult to identify a specific picture or video simply by looking through thumbnails.

57. The inventor of the '848 Patent disclosed a solution to these problems, including, techniques that enable a user to identify and search through recorded content more efficiently and effectively. For example, the '848 Patent discloses

executing a face recognizing process on the recorded pictures and allows a user to register pictures of a specific person in an organized manner. Further, the '848 Patent also discloses techniques whereby once a picture of a specific person is registered, future pictures of the same person will continue to be categorized and associated with the previously identified pictures of that person. Further, the '848 Patent also discloses displaying thumbnails corresponding to recorded images with an icon having predetermined shape when an importance level is set for a specific recorded image. The '848 Patent also discloses recording video information including a plurality of sections corresponding to a plurality of thumbnails and displaying the thumbnails. This manner of recording and reproducing images and video information allows users of the recording and reproducing apparatus to navigate and search through pictures and video in a more manageable and efficient manner.

58. Indeed, the state of the art of cellular phones at that time lagged behind the inventions of the '848 Patent. For example, the first iPhone was released in June 2007. *See* Ex. 2011. But the first iPhone did not have the ability to even record video (rather, just still photographs) or any facial recognition capacity let alone using facial recognition technology in conjunction with picture organization. *See id.* It was not until November 2017, in conjunction with the release of the iPhone X, that Apple added facial recognition technology (Face ID) to the iPhone and even that

technology was used for device unlock/authentication purposes and not for picture organization. *See* Ex. 2012; Ex. 2013.

59. And Apple did not introduce its “People Album” functionality until the release of iOS 12 in September 2018 and is a feature that continues to be in its products (*i.e.*, present in the recently-released iOS 18). *See* Ex. 2014 (“Find people in Photos on iPhone” page from the iOS 12 user guide); Ex. 2015 (“Find and name people and pets in Photos on iPhone” page from the iOS 18 user guide); *see also* Ex. 2016 (“Find people in Photos on iPhone” page from the iOS 13 user guide); Ex. 2017 (“Find people in Photos on iPhone” page from the iOS 14 user guide); Ex. 2018 (“Find people in Photos on iPhone” page from the iOS 15 user guide); Ex. 2019 (“Find and identify people in Photos on iPhone” page from the iOS 16 user guide); Ex. 2020 (“Identify people and pets in photos on iPhone” page from the iOS 17 user guide); Ex. 2021 (Apple Support page titled “Use the People & Pets album in Photos on your iPhone or iPad”).

60. Indeed, apart from Apple products, functionality that combines a facial recognition process with registering/associating people with pictures for efficient categorization and later reproduction is now commonplace across a plethora of other devices or offered services such as Android phones (Ex. 2022), Windows laptops (Ex. 2023), and Amazon photos (Ex. 2024).

61. In view of the above facts, it is my opinion that the inventor of the '848 Patent was well ahead of her time. The inventions in the '848 Patent comprise image recording and storing means, execution of a facial recognition process on stored images, where the images can be used in a variety of modes. Thus, the '848 Patent discloses a novel video recording and reproducing apparatus (*e.g.*, cellular phone) that provides users with numerous smartphone functionalities that are familiar to, and expected from, users today but that were not found in the leading smartphones of that time.

62. The claims of the '848 Patent are directed towards, among other things, allowing a user to register and reproduce pictures of a specific person in an organized manner and the ability to register a picture of a specific person and, thereafter, future pictures of that person will be associated with their likeness.

63. The novelty of the '848 Patent is also evident by the fact that a reexamination was filed against the '848 Patent by Apple, yet a reexamination certificate issued on March 18, 2022, indicating that the challenged claims of the '848 Patent are novel and non-obvious even after additional examination by the USPTO.

C. Prosecution History of the '848 Patent

64. Dr. Bederson provides a summary of the prosecution history in his declaration, including the reexamination history. *See* Ex. 1005, ¶¶45-49.

65. Regarding the original application’s prosecution history, the applicant did not “concede” that the prior art taught any particular limitation as Dr. Bederson asserts. *See id.*, ¶46. Rather, the applicant’s response to the examiner’s September 21, 2017 office action explained how the prior art did not disclose limitations related to the first and second setting mode, *i.e.*, the “registration limitations” as Dr. Bederson paraphrases. *See Ex. 1003*, 255-260.

66. Regarding the ’848 Patent’s reexamination prosecution history, Dr. Bederson notes what he describes as an “apparent inconsistency” in the examiner’s rationale for allowing challenged claims 11-12, 16-17, and 19-20. *See Ex. 1005*, ¶48. There is no such inconsistency. That the examiner mentioned a portion of what the prior art did or did not allegedly teach is irrelevant—he allowed challenged claims 11-12, 16-17, and 19-20 after reexamination. Moreover, the Patent Owner filed a “Comment on Statement of Reasons for Patentability and/or Confirmation.” *See Ex. 1003*, 45-48. In it, the Patent Owner made that clear that while it agreed with the examiner’s ultimate conclusion in confirming challenged claims 11-12, 16-17, 19-20, and 84 because the prior art did not teach or suggest the claimed features set forth in the claims, the Patent Owner did not agree with “each and every characterization and assertion contained in the Examiner’s [Notice of Intent to Issue *Ex Parte* Reexamination Certificate and Statement of Reasons for Patentability and/or Confirmation].” *See id.* at 45-46.

67. To the extent additional portions of the '848 Patent's prosecution history are relevant, I have addressed them herein.

D. Response to Dr. Bederson's "TECHNOLOGY BACKGROUND" Discussion

68. In Section VII of the Bederson Decl., Dr. Bederson provides his opinions with respect to an overview of the technology. *See* Ex. 1005, ¶¶50-59. While I disagree with Dr. Bederson's generalizations and characterizations of the patented technology, I have not addressed each of Dr. Bederson's statements in this section because they are not relevant to the grounds he presents in his declaration. Where applicable, I have addressed Dr. Bederson's characterization of the patented technology while rebutting these grounds specifically. The fact that additional facial recognition and/or image or video reproduction components existed at the time of the '848 Patent is irrelevant, as Dr. Bederson has provided no opinions on how these devices relate to the claimed inventions as a whole. Indeed, I understand that the law recognizes that, at some level, all inventions are combinations of known components; this alone cannot establish invalidity.

E. Challenged Claims

69. The challenged claims are 11-12, 16-17, 19-20, and 84. The language of these claims is as follows:

'848 Patent Claim Element Number	Claim Text
[8.pre]	A recording and reproducing apparatus for recording and reproducing image information, comprising:
[8.a]	a processor; and
[8.b]	a memory coupled to the processor and storing instructions that, when executed by the processor, cause the processor to:
[8.c]	capture a photograph and generate image information of the photograph;
[8.d]	record the image information in a recording medium;
[8.e]	execute a face-recognizing process on the image information to recognize a face;
[8.f]	reproduce the recorded image information from the recording medium;
[8.g]	register a person in the image information as a specific person in a mode selected from a first setting mode and a second setting mode, wherein, when the first setting mode is selected, a person with a face is obtained by newly photographing the person in a photographing mode and thereafter registered as the specific person, and,
[8.h]	when the second setting mode is selected, a person with a face in the image information is selected from a plurality of faces in the image information recorded in the recording medium and thereafter registered as the specific person; and
[8.i]	selectively reproduce the recorded image information which includes the registered specific person.
[11.pre]	The recording and reproducing apparatus according to claim 8,
[11.a]	wherein the memory further stores instructions that, when executed by the processor, cause the processor to: control the reproduction of the image information in a reproducing mode set from one of a first reproducing mode and a second reproducing mode,
[11.b]	wherein a reproducing time required for reproducing the image information under the first reproducing mode is shorter than a reproducing time required for reproducing the image information under the second reproducing mode,

'848 Patent Claim Element Number	Claim Text
[11.c]	and the image information reproduced under the second mode includes the image information reproduced under the first reproducing mode and other of the image information not reproduced under the first reproducing mode.
[12.pre]	The recording and reproducing apparatus according to claim 11,
[12.a]	wherein the memory further stores instructions that, when executed by the processor, cause the processor to: control the reproduction of the image information in the reproducing mode set from one of the first reproducing mode, the second reproducing mode, and a third reproducing mode,
[12.b]	wherein a reproducing time required for reproducing the image information under the third reproducing mode is longer than the reproducing time required for reproducing the image information under the second reproducing mode.
[13.pre]	A recording and reproducing apparatus for recording and reproducing image information, comprising:
[13.a]	a photographing sensor configured to photograph an object and generate image information;
[13.b]	a recorder configured to record the image information generated by the photographing sensor in a recording medium;
[13.c]	a reproducer configured to reproduce the image information recorded by the recorder;
[13.d]	processing circuitry configured to:
[13.e]	execute a face-recognizing process on the image information generated by the photographing sensor to recognize a face,
[13.f]	register a person in the image information as a specific person in a mode selected from a first setting mode and a second setting mode, wherein, when the first setting mode is selected, a person with a face is obtained by newly photographing the person in a photographing mode and thereafter registered as the specific person, and,

'848 Patent Claim Element Number	Claim Text
[13.g]	when the second setting mode is selected, a person with a face in the image information is selected from a plurality of faces in the image information recorded in the recording medium and thereafter registered as the specific person,
[13.h]	firstly pick out image information which includes the registered specific person,
[13.i]	secondly pick out the image information based on a predetermined condition from among the picked-out image information which includes the registered specific person, the predetermined condition being set in accordance with an instruction by a user, and
[13.j]	control the reproducer to selectively and sequentially reproduce the image information picked out based on the predetermined condition.
[16.pre]	The recording and reproducing apparatus according to claim 13,
[16.a]	wherein the processing circuitry is further configured to control the reproducer to selectively and sequentially reproduce the image information picked out based on the predetermined condition in a reproducing mode set from one of a first reproducing mode and a second reproducing mode, and
[16.b]	wherein a reproducing time required for reproducing the image information under the first reproducing mode is shorter than a reproducing time required for reproducing the image information under the second reproducing mode, and
[16.c]	the image information reproduced under the second mode includes the image information reproduced under the first reproducing mode and other of the image information not reproduced under the first reproducing mode.
[17.pre]	The recording and reproducing apparatus according to claim 16,
[17.a]	wherein the processing circuitry is further configured to control the reproducer to selectively and sequentially reproduce the

'848 Patent Claim Element Number	Claim Text
	image information picked out based on the predetermined condition in the reproducing mode set from one of the first reproducing mode, the second reproducing mode, and a third reproducing mode, and
[17.b]	wherein a reproducing time required for reproducing the image information under the third reproducing mode is longer than the reproducing time required for reproducing the image information under the second reproducing mode.
[18.pre]	A recording and reproducing apparatus for recording and reproducing image information, comprising:
[18.a]	a photographing sensor configured to photograph an object and generate image information;
[18.b]	a recorder configured to record the image information generated by the photographing sensor in a recording medium;
[18.c]	a reproducer configured to reproduce the image information recorded by the recorder;
[18.d]	processing circuitry configured to:
[18.e]	execute a face-recognizing process on the image information generated by the photographing sensor to recognize a face;
[18.f]	register a person in the image information as a specific person, wherein a person with a face is obtained by newly photographing the person in a photographing mode and thereafter registered as the specific person;
[18.g]	firstly pick out image information which includes the registered specific person,
[18.h]	secondly pick out the image information based on a predetermined condition from among the picked-out image information which includes the registered specific person, the predetermined condition being set in accordance with an instruction by a user, and
[18.i]	control the reproducer to selectively and sequentially reproduce the image information picked out based on the predetermined condition.

'848 Patent Claim Element Number	Claim Text
[19.pre]	The recording and reproducing apparatus according to claim 18,
[19.a]	wherein the processing circuitry is further configured to control the reproducer to selectively and sequentially reproduce the image information picked out based on the predetermined condition in a reproducing mode set from one of a first reproducing mode and a second reproducing mode, and
[19.b]	wherein a reproducing time required for reproducing the image information under the first reproducing mode is shorter than a reproducing time required for reproducing the image information under the second reproducing mode, and
[19.c]	the image information reproduced under the second mode includes the image information reproduced under the first reproducing mode and other of the image information not reproduced under the first reproducing mode.
[20.pre]	The recording and reproducing apparatus according to claim 19,
[20.a]	wherein the processing circuitry is further configured to control the reproducer to selectively and sequentially reproduce the image information picked out based on the predetermined condition in the reproducing mode set from one of the first reproducing mode, the second reproducing mode, and a third reproducing mode, and
[20.b]	wherein a reproducing time required for reproducing the image information under the third reproducing mode is longer than the reproducing time required for reproducing the image information under the second reproducing mode.
[84.pre]	A recording and reproducing apparatus for recording and reproducing image information, comprising:
[84.a]	a processor;
[84.b]	a display displaying a first option and a second option, wherein when the first option is selected, the recording and reproducing apparatus enters a record mode to capture video information, and

'848 Patent Claim Element Number	Claim Text
	when the second option is selected, the recording and reproducing apparatus enters a reproduction mode to reproduce and display recorded video information;
[84.c]	a memory coupled to the processor and storing instructions that, when executed by the processor, cause the processor to:
[84.c.i]	capture a photograph and generate image information of the photograph;
[84.c.ii]	record the image information in a recording medium;
[84.c.iii]	execute a face-recognizing process on the image information to recognize a face;
[84.c.iv]	reproduce the recorded image from the recording medium;
[84.c.v]	register a person in the image information as a specific person in a mode selected from a first setting mode and a second setting mode, wherein, when the first setting mode is selected, an image information of a person with a face is obtained by newly photographing the person with a face in a photographing mode and, thereafter, the image information of the person with a face is used to register the person with a face as the specific person, and,
[84.c.vi]	when the second setting mode is selected, a person with a face in an image information of a person with a face is selected from a plurality of faces in the image information recorded in the recording medium and, thereafter, the image information of the person with a face is used to register the person with a face as a specific person;
[84.c.vii]	selectively reproduce the recorded image which includes the registered specific person; and
[84.c.viii]	generate a thumbnail corresponding to the recorded image in the recording medium such that the thumbnail is displayed on the display with an icon having a predetermined shape when an importance level is set for the recorded image via a user interface;
[84.d]	a touch panel adhered to a screen of the display, wherein the first setting mode and the second setting mode are each selected using the touch panel;

'848 Patent Claim Element Number	Claim Text
[84.e]	a video camera providing video image data, wherein, in response to the face-recognizing process recognizing that a face of a person is included in the video image data, the display displays the video image data with a frame surrounding at least a portion of the face of the person;
[84.f]	an analog/digital converter, wherein the analog/digital converter is configured to convert analog image data corresponding to the captured photograph into a digital image signal; and
[84.g]	a codec for compressing the digital image signal using a predetermined compression encoding method and generating encoded image information, wherein the encoded image information is stored in the recording medium,
[84.h]	wherein the video camera captures video information corresponding to a scene and the processor:
[84.h.i]	automatically sets a plurality of sections corresponding to the video information of the scene; and
[84.h.ii]	generates a plurality of thumbnails corresponding to the plurality of sections, wherein each of the plurality of thumbnails is associated with the same video information corresponding to the scene, and the display displays the plurality of thumbnails; and
[84.i]	wherein the display is configured to display at least a plurality of images recorded in the recording medium such that contents of each image in the plurality of images includes a face of a different person and background objects and displaying the plurality of images includes displaying the faces without displaying all of the background objects included in the contents of each image of the plurality of images.

70. From my review of the materials, including the '848 Patent's prosecution history including the reexamination history of the '848 Patent, I understand that claim 8 was canceled during reexamination. However, because claim

11 depends from claim 8 and because claim 11 was confirmed as patentable during reexamination, the cancellation of claim 8 does not have an impact on my patentability analysis of dependent claims 11 and 12. I have a similar understanding with respect to claim 13 (cancelled during reexamination) and its dependent claims 16-17, and claim 18 (cancelled during reexamination) and its dependent claims 19-20.

VI. CLAIM CONSTRUCTION FOR THE '848 PATENT

71. For any terms not specifically construed, I have applied the ordinary and customary meaning that these terms would have had to a person of ordinary skill in the art at the time of the invention (around May 2008) in view of the patent's specification. In other words, I have interpreted the remaining terms in accordance with the "plain and ordinary" meaning.

A. "Mode"

72. Due to Petitioner's and Dr. Bederson's incorrect understanding and application of the term "mode," I submit that the term "mode" as appearing in the claims would be understood by a POSITA as "an operational state that a system has been switched to."

73. This consistent application of what a mode is applies to the terms "first setting mode" (element [8.g]/[13.f]/[84.c.v]), "second setting mode" (element [8.g]/[13.f]/[84.c.v]), "first reproducing mode" (element [11.a]/[16.a]/[19.a]),

“second reproducing mode” (element [11.a]/[16.a]/[19.a]), “third reproducing mode” (element [12.a]/[17.a]/[20.a]),

74. Such a plain and ordinary meaning of the word “mode” is supported by the ’848 Patent. As noted in the Institution Decision (at 6-7), the ’848 Patent describes a “standard reproducing mode,” wherein “all chapters are sequentially reproduced in an order of smaller chapter ID, irrespective of the chapter importance level set to each chapter.” *Id.* at 9:20–28. The ’848 Patent also describes an “express reproducing mode,” wherein “only the chapters having the chapter importance level ‘3’ or smaller (only the chapters having the importance levels ‘1’ to ‘3’) are reproduced.” *Id.* at 9:29–45. The ’848 Patent further describes a “superexpress reproducing mode,” wherein “only the chapters having the chapter importance level ‘1’ are reproduced.” *Id.* at 9:46–54.

75. The ’848 Patent explains that the user selects between the three different reproducing *modes*—standard, express, superexpress—from a menu. *See* Ex. 1001, 9:20-22 (“as reproduction is performed by selecting as a reproducing mode a ‘standard reproducing mode’ from the menu”), 9:29-30 (“as a user starts reproducing by selecting as the reproducing mode an ‘express reproducing mode’”), 9:46-47 (“as a user starts reproducing by selecting as the reproducing mode a ‘superexpress reproducing mode’”); *see also id.* at Figure 9.

76. A POSITA would understand that this disclosure in the '848 Patent conveys that a user selects different modes that yield different operations, here, choosing specific chapters and playing back select information.

77. A POSITA's understanding of what is a "mode" is further supported by extrinsic evidence. For example, multiple dictionary definitions distinguish "filter" and "mode" and contrary to Dr. Bederson's equating "filters" to "modes":

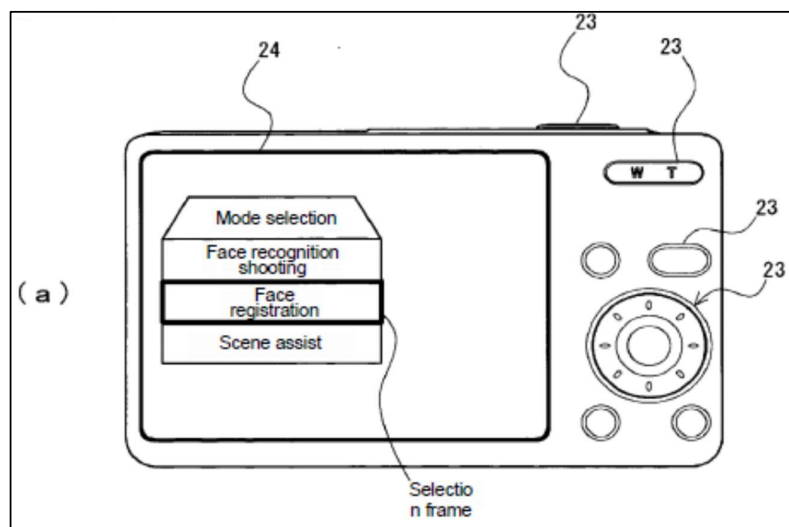
Source	Filter Definition	Mode Definition
PC-Mag (Ex. 2027)	"To select data. Filters use patterns (masks) against which data are compared and only matching data are "passed through," hence the concept of a filter."	"an operational state that a system has been switched to."
McGraw-Hill Dictionary of Scientific and Technical Terms, 6 th ed. (2003) (Ex. 2028)	"[Comput Sci] A device or program that separates data or signals in accordance with specified criteria." Ex. 2028 at 799	"One of several alternative conditions or methods of operation of a device." Ex. 2028 at 1357

78. Even the prior art selected by Petitioner uses "mode" consistent with its plain meaning, "an operational state that a system has been switched to."

79. For example, Dr. Bederson acknowledges that "Nozaki teaches that '[f]irst, the user sets a shooting mode of the electronic camera to a 'face registration mode' by using the operating member 23.'" See Ex. 1005, ¶78 (citing Ex. 1006, Fig. 2 (flowchart step S101), [0062]). Earlier in paragraph [0062], Nozaki states that "[t]he 'face registration mode' is a type of shooting mode." Ex. 1006, [0062].

80. Nozaki further differentiates between “face registration mode” and the “face recognizing shooting mode,” where the latter is a different type of shooting mode selected by the user which performs a different function. *See id.* at [0084].

81. For example, when describing Figures 3(a)-(b), Nozaki discusses bringing up a “mode selection screen” on the liquid crystal display 24, and a user can select between a “face registration mode” and a “face recognizing shooting mode” (among other options) on the mode selection screen:



See id. at Figure 3(a), [0063], [0085].

82. Indeed, depending on which mode the user selects, wholly different processing operations are performed by the CPU 26 in Nozaki. *Compare id.* at [0062]-[0083] (“Operations in Face Registration Mode”) and Figure 2 (flow chart relating to the Face Registration Mode) *with* [0084]-[0092] (“Operations in Face

Recognizing Shooting Mode”) and Figure 7 (flow chart relating to the Face Recognizing Shooting Mode).

83. Dr. Bederson even recognizes that “Nozaki states that ‘[t]he input button of the operating member 23 accepts switching input, for example, shooting modes of an electronic camera (such as normal shooting mode, regeneration mode, face registration mode, and face recognizing shooting mode).’” *See* Ex. 1005, ¶146 (citing to Ex. 1006, [0049]).

84. Haitani and Graham also use the term “mode” consistently with its plain and ordinary meaning. *See, e.g.*, Ex. 1007, 18:59-60; 20:66-21:1; 21:22-28; 29:61-64; Ex. 1008, ¶¶249-251.

85. Dr. Bederson admits that Haitani distinguishes between filters and modes. Ex. 2031, at 49:13-18.

86. In other words, the prior art uses “mode” consistently with its plain and ordinary meaning as understood by a POSITA—*i.e.*, “an operational state that a system has been switched to.”

VII. SUMMARY OF MY OPINIONS

87. After considering the material available to me in this proceeding in view of my experience in the field of image recording and reproduction and processing, it is my opinion that the challenged claims of the ’848 Patent are

patentable over the cited prior art. Specifically, it is my opinion that Dr. Bederson has not shown that:

- a. Challenged claims 11-12, 16-17, 19-20 are rendered obvious by International Publication No. WO 2007/060980 A1 (“Nozaki”) (Ex. 1006) in view of International Publication No. WO 2007/060980 A1 (“Nozaki”) (Ex. 1006);
- b. Challenged claim 84 is rendered obvious by the combination of Nozaki, Haitani, and U.S. Patent Application Publication No. US 2004/0095376 A1 (“Graham”) (Ex. 1008);
- c. Challenged claim 84 is rendered obvious by the combination of Nozaki, Haitani, and Korean Unexamined Patent Application Publication No. 10-2007-0017068 A (“Kim”) (Ex. 1009).

88. For example, while digital cameras may have existed, none of the prior art references or products reference by Dr. Bederson comprise multiple modes for reproducing image information, as is required by Claims 11-12, 16-17, 19-20 of the ’848 Patent. Specifically, the lone “filtering” functionality disclosed in Haitani cannot be a first, second, and third reproducing mode, as claimed. Moreover, it is my understanding that, even if the claimed elements of the ’848 Patent independently existed in the prior art references (which they do not), such disclosure is not enough to demonstrate that the challenged claims are unpatentable.

89. Accordingly, and as I will explain in greater detail in the following sections, it is my opinion that Claims 11-12, 16-17, 19-20, and 84 of the '848 Patent are patentable over the art and arguments that Petitioner and Dr. Bederson have presented. I discuss the bases for my opinions in the following section.

VIII. THE PRIOR ART

90. Here, I will provide a brief overview of each of the references used in Dr. Bederson's obviousness combinations.

A. Description of Nozaki

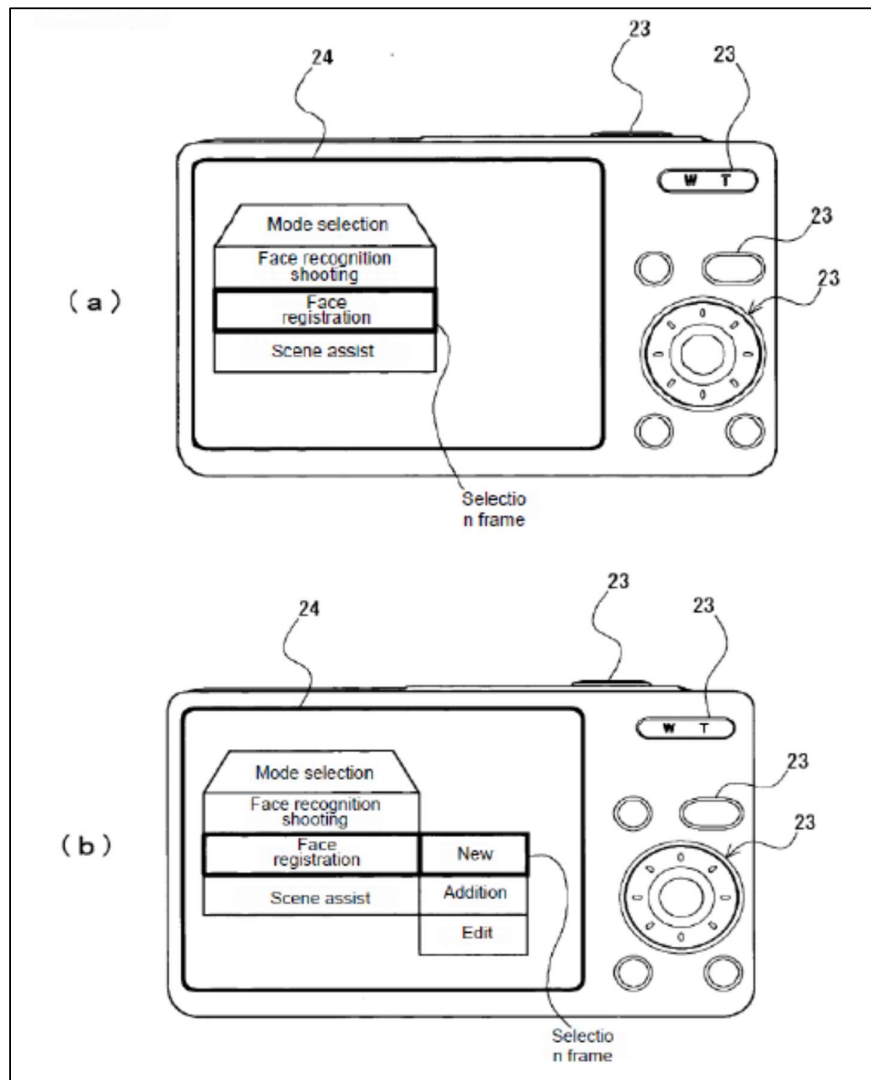
91. Nozaki, titled "Electronic Camera and Image Processing Device," was filed as an international patent application on November 22, 2006 and published on May 31, 2007.

92. Nozaki purportedly discloses fifty-seven different inventions in seven different embodiments. Ex. 1006, ¶¶[0009]-[0038]. Nozaki discloses an electronic camera with an imaging element, an image processing section, a face detecting section, a control section, a face image creating section, a face recognition data creating section, and a recording section. The imaging element generates an imaging signal by photo-electrically converting the image of an object captured by an imaging optical system. The image processing section creates face registration image data from the image signal sent from the imaging element and creates through image data from the image signal. The face detecting section detects a face region

on the imaging screen on the basis of the through image data. The control section adjusts the imaging parameter of the imaging optical system according to the detected position of the face region. The face image creating section cuts out the image of the face region to create face image data. The face recognition data creating section extracts a feature point of the face of the imaged person from the face region of the face registration image data and creates face recognition data according to the feature points. The recording section records the face recognition data or the face image data. Ex. 1006, Abstract.

93. For example, and as noted in the Institution Decision (at 24) Nozaki relates to “an electronic camera and an image processing device provided with human face recognition functions.” Ex. 1006, ¶ 1. Nozaki describes a face registration mode, which is “a type of shooting mode with which a user can shoot the face of a registered person to generate face recognizing data.” *Id.* ¶ 62.

94. Nozaki’s Figures 3(a) and 3(b), below, depict an example of a mode selection screen displayed on the liquid crystal monitor 24 of an electronic camera. Ex. 1006 ¶¶ 41, 63, 64.



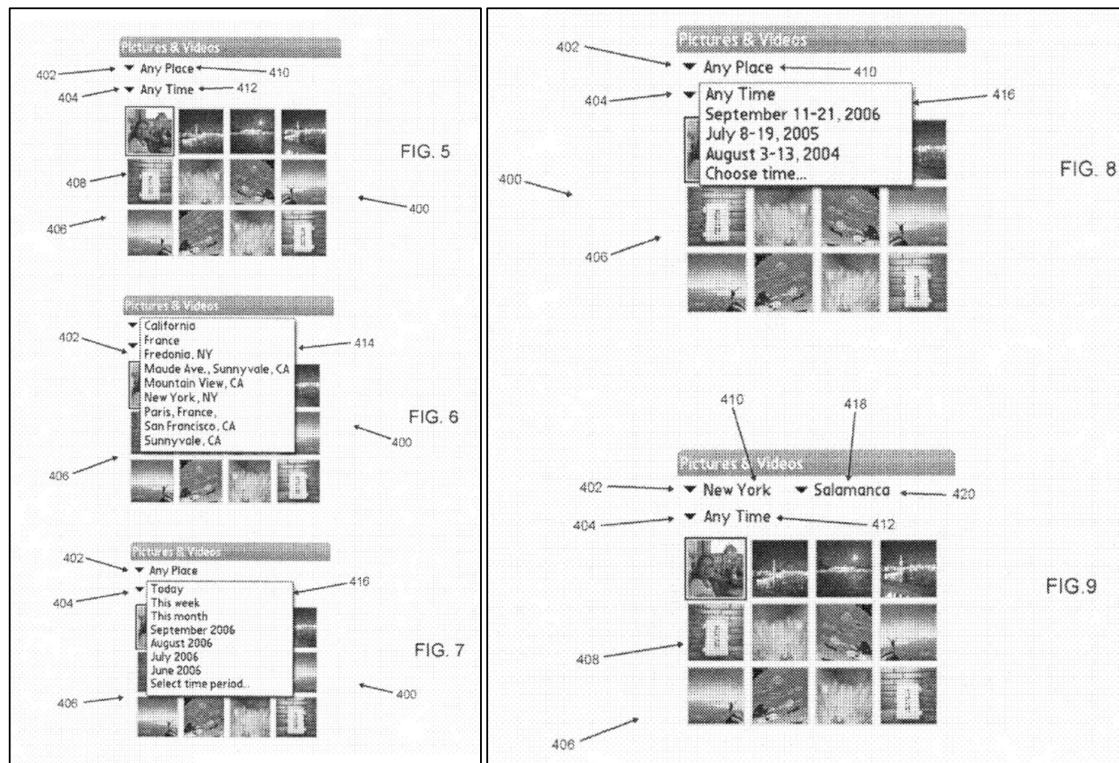
Ex. 1006, Figs. 3(a)-(b).

B. Description of Haitani

95. Haitani, titled "Method and System for Processing Images Using Time and Location Filters," was filed on March 22, 2007 and issued on May 30, 2017.

96. Haitani discloses a device that processes images (*e.g.*, sort, group, file, e-mail, etc.) using various filters. The filters relate to non-image data in the image files to be processed, and may include time and location filters. Ex. 1007, Abstract.

97. As depicted below in Figures 5-9, Haitani's various filters are not separate modes or operational states of the portable hand-held device 10 similar, for example, to the different and distinct "face registration" and "scene assist" modes discussed in Figures 3(a)-(b) of Nozaki. Rather, a user choosing various filters in Haitani that display images or videos is operating in a single "review" mode—a user is, at all times, in the "Pictures & Video" interface with the option of selecting one or more drop down menus that filter images or video:



See Ex. 1007, Figs. 5-9.

C. Description of Graham

98. Graham, titled “Techniques for Displaying Information Stored in Multiple Media Documents” was filed on June 18, 2003 and published on May 20, 2004.

99. Graham discloses techniques for providing a graphical user interface (GUI) that displays a representation of stored information that may include information of one or more types. The displayed representation may include representations of information of the one or more types. The GUI enables a user to navigate and skim through the stored information and to analyze the contents of the

stored information. The stored information may include information captured along the same timeline or along different timelines. Ex. 1008, Abstract.

D. Description of Kim

100. Kim, titled “Apparatus and Method for Partitioning Videos According to Topic,” was filed on August 4, 2006 and published on February 8, 2007.

101. Kim discloses a way to partition a video according to topic. Kim discloses a start shot determining unit that detects a plurality of key frames using character information in a vide sequence composed of a plurality of frames and determines the detected key frames as the start shot of each subject, and a topic list generating unit that generates a topic list using the starting shot of each topic. Ex. 1009, Abstract.

IX. ANALYSIS OF INSTITUTED GROUNDS

102. I understand that the Board instituted review of the ’848 Patent on three grounds:

Ground	Claims Challenged	35 U.S.C. §	Reference(s)
1	11-12, 16-17, and 19-20	103(a) (pre-AIA)	Nozaki, Haitani
2	84	103(a) (pre-AIA)	Nozaki, Haitani, Graham
3	84	103(a) (pre-AIA)	Nozaki, Haitani, Kim

Institution Decision at 9.

103. I have analyzed each of the instituted grounds. As explained in greater detail below, it is my opinion that each of these grounds does not show that the challenged claims of the ’848 Patent are unpatentable as obvious.

104. As I discuss herein, Dr. Bederson and Petitioner failed to show that the challenged claims of the '848 Patent are obvious. Note that my decision not to discuss a particular limitation in detail here is not an indication that I agree that limitation is met by the prior art. Rather, I have elected to focus my opinions on the most glaring deficiencies in Dr. Bederson's obviousness analysis.

105. To show how the claims are not obvious over the prior art, I will follow the framework of the four *Graham* factors.

106. Regarding level of ordinary skill in the art, I have provided my opinions regarding the appropriate level of ordinary skill in the art in Section III(D) of this declaration. I incorporate that discussion by reference into my opinions for each Ground.

107. Regarding the scope and content of the prior art, I have provided a brief overview of the four prior art references at issue in Section VII and incorporate that discussion by reference herein for each respective Ground that a given prior art reference is discussed.

108. Regarding secondary considerations of non-obviousness, I note that Dr. Bederson did not identify or discuss any secondary considerations in his declaration. See Ex. 1005, ¶¶180-181. In forming my opinions about whether or not the claims of the '848 Patent are obvious, I also accounted for secondary considerations of nonobviousness. The inventor arrived at these solutions no later than May 19, 2008.

It is notable that nobody arranged the elements in the novel way as claimed in the '848 Patent, and Dr. Bederson could not identify a single reference—whether prior art patent, publication, or system—disclosing each limitation as claimed as evidenced by my declaration. Accordingly, secondary considerations further support that the claims at issue here are not obvious. *See also, infra*, ¶¶58-63.

109. Regarding the differences between the prior art and the claimed invention, I set forth my detailed analysis regarding those differences in the subsequent sections for each Ground.

A. Ground 1: Nozaki in view of Haitani Does Not Render Claims 11-12, 16-17, and 19-20 Obvious

110. For Ground 1, neither the Petitioner nor Dr. Bederson demonstrate that Nozaki alone anticipates challenged claims 11-12, 16-17, and 19-20. In an attempt to fill in the gaps of the deficiencies of Nozaki, Petitioner and Dr. Bederson have attempted to combine Nozaki and Haitani. However, Petitioner and Dr. Bederson have failed to show both that a POSITA would be motivated to combine Nozaki and Haitani and, even if the two references are combined, that the combination of Nozaki and Haitani discloses each element of challenged claims 11-12, 16-17, and 19-20.

1. A POSITA Would Not Have Found It Obvious To Combine Nozaki and Haitani for Claims 11-12, 16-17, and 19-20

111. Ground 1 initially fails because Dr. Bederson has stated only vague, conclusory, and unsupported reasons to combine Nozaki and Haitani render obvious challenged claims 11-12, 16-17, and 19-20. *See* Ex. 1005, Section IX(A).

112. Dr. Bederson forwards two reasons that a POSITA would be motivated to combine Nozaki and Haitani:

- a. “Nozaki and Haitani are analogous art to the ’848 patent, and as a result it is my opinion that a POSITA would have found it obvious to combine them for that reason alone. . . . Nozaki and Haitani also disclose devices with digital cameras that can capture and reproduce image/video files.” Ex. 1005, ¶66.
- b. “Nozaki and Haitani are compatible with and complementary to each other, and in my opinion a POSITA would have been motivated to combine them for this additional reason.” *Id.*, ¶67.

113. I disagree with Dr. Bederson’s conclusory opinions.

114. As to Dr. Bederson’s primary rationale relating to “analogous art,” merely because the ’848 Patent discloses a “reproduction and reproducing apparatus” and the Nozaki and Haitani each disclose digital cameras, I disagree that a POSITA would be motivated to combine Nozaki and Haitani. Under Dr. Bederson’s rationale, any two references that mention digital cameras could be

potentially be combined even if those references solve different problems from each other (as is the case with Nozaki and Haitani) and/or the '848 Patent. I disagree that a POSITA would ignore the problems that prior art sought to solve in determining whether the two references could be analogous art and/or provide a motivation to combine those two references.

115. As to Dr. Bederson's compatibility and complementary rationale, he provides nothing but conclusory reasoning to support such his opinion. *See id.*, ¶67. Dr. Bederson states that "Nozaki uses face-recognition technology to organize registered individuals. [] Although Nozaki discloses reproducing image/video files based on stored information about those files (e.g., face-recognition data, time/date data, event data, etc.), Nozaki does not explore the ways that the recorded information can be used to tailor the reproduction search process to produce broader or narrower results. Haitani teaches how to achieve this objective by disclosing selectively reproducing image/video information using combinations of filters based on data that the Nozaki device already generates, including face-recognition data, date/time information, and event data." *See id.*, ¶67.

116. A POSITA would not be motivated to combine the teachings of Nozaki and Haitani because they are directed to solving different problems and use different technology and/or structures to solve these problems. It is my opinion that the design requirements for Nozaki and Haitani are substantially different. As Dr. Bederson

concedes that Nozaki has no disclosure to sort images, nor contemplates the inclusion of such a method (*see id.* at ¶67), there is no reason that a POSITA would look to Haitani's filters to purportedly solve a problem that Nozaki does not contemplate. Dr. Bederson has not considered the two references as a whole and has not accounted for these differences. Instead, Dr. Bederson selected portions of each reference and used hindsight to assemble a new system without accounting for the different objectives and goals of the systems in Nozaki and Haitani.

117. Dr. Bederson also does not explain how a POSITA would implement Haitani's filtering feature in Nozaki's device other than his say so. Instead, Dr. Bederson conjures a purported need, describes some benefits in generalities ("improve the efficiency"), and claims Haitani's filtering feature "could have easily been implemented in the Nozaki device." *See id.*, ¶68. But describing potential improvements that are accomplished by the claims of the '848 Patent is the definition of hindsight. Neither Petitioner nor its expert attempts to quantify such "easy" implementation techniques. Implementing an entirely different function on a processor cannot necessarily be expected to be easy. In the design of digital camera products, a POSITA would understand that there are limits to the amount of hardware resources such as CPU power, memory capacity, storage capacity, and battery, etc. For example, when considering the face recognition function of Nozaki, Nozaki discloses that the computation time needs to be adjusted. *See, e.g.*, Ex. 1006,

¶¶[0008], [0040], [0052], [0168]-[0169] This illustrates the difficulty to “easily implement” and increase the hardware resources of digital camera products. Thus, if non-image data such as location information, event information, etc. is further added to Nozaki’s image data in the form of Haitani’s “various filters”, a POSITA would recognize there may be significant redesigning of hardware necessary in Nozaki. For example, the digital camera disclosed by Nozaki does not disclose the GPS necessary to obtain location information. Dr. Bederson ignores these considerations when he opines Haitani’s filtering feature “could have easily been implemented in the Nozaki device.

118. In addition, Dr. Bederson’s reliance on Haitani’s filters does not provide motivation to a POSITA for combining Nozaki with Haitani for another reason. *See id.* at ¶¶67-68. As more fully discussed with respect to limitation [11.a], in Section IX(A)(3), Haitani’s filters are not modes and do not teach or disclose the first or second reproducing modes of challenged claims 11-12, 16-17, and 19-20. In addition, Dr. Bederson’s cited publication (Ex. 1012) further cuts against any potential motivation to combine Nozaki with Haitani. *See* Ex. 1005, ¶68; *see also id.* at ¶91 (citing Ex. 1012 for limitation [8.i]). As further explained in Section IX(A)(3) relating to limitation [11.a], Dr. Bederson’s publication distinguishes “mode” from “filter” which supports my opinion that a POSITA would not look to combine Haitani with Nozaki.

119. It is my opinion that a POSITA would not be motivated to combine two references to arrive at the claimed invention if the combination ultimately does not teach each element of the claimed invention. As such, because the combination of Nozaki and Haitani does not teach all of the limitations of the challenged claims (as stated herein Section IX(A), even if a POSITA was motivated to combine the two references (which a POSITA would not), such a conclusion further supports my opinion why a POSITA would not combine the two references.

120. In the Institution Decision, I understand that the Board analyzed the rationale to combine Nozaki and Haitani. *See* Institution Decision at 36-39. However, the Patent Owner's arguments in its Preliminary Response focused only on a POSITA's motivation to combine the various embodiments within Nozaki as part of forming an obviousness rejection. *See id.*; *see also* Patent Owner Preliminary Response at 26-29 (arguments regarding the same included in the section titled "Grounds 1-3 Fail Because Petitioner Fails To Set Forth *Any* Motivation To Combine The Different Embodiments Of Nozaki Upon Which It Relies").

121. In other words, although the Petitioner set forth similar motivations to combine Nozaki and Haitani (Institution Decision at 36-37, citing Dr. Bederson's declaration, Ex. 1005 at ¶¶67-68), the Board only addressed Patent Owner's then-arguments regarding Nozaki's embodiments. The Board did not consider that a

POSITA would not combine Nozaki and Haitani for the reasons set forth above and in limitation [11.a] herein.

122. For all of the foregoing reasons, it is my opinion that a POSITA would not be motivated to combine Nozaki and Haitani.

2. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Haitani to Disclose Limitation [8.i] of Claim 8.*

123. In my opinion, a POSITA would not have found it obvious to combine Nozaki with Haitani to comprise a processor that “selectively reproduce the recorded image information which includes the registered specific person” as claimed in limitation [8.i].

124. As explained further above in Section IX(A)(1), which I incorporate by reference here, Dr. Bederson provides nothing but improper hindsight to combine Haitani with Nozaki. *See* Ex. 1005, ¶¶90-93.

125. Dr. Bederson opines that “[a]lthough Nozaki does not expressly disclose that selecting an item from the lower part of the “detailed information screen” in Figure 5 will enable a user to reproduce the entire image/video file associated with that item (as opposed to the trimmed down “index image” generated from that photo), it would have been obvious to implement such feature in view of Haitani.” *See id.*, ¶90. But a POSITA would not be motivated to look to or incorporate Haitani’s filers to selectively reproduce an image.

126. I further disagree with Dr. Bederson’s claim that “a POSITA would also recognize that Nozaki already implements a version of the ‘filter’ criteria that Haitani describes.” *See id.*, ¶92. Indeed, in support of his purported motivation to combine rationale, Dr. Bederson states that “Nozaki does not explore the ways that the recorded information can be used to tailor the reproduction search process to produce broader or narrower results” and then cites to Haitani’s filters to disclose this deficiency. *See id.*, ¶67. In other words, Dr. Bederson stated that Nozaki **does not** have the filtering criteria in Haitani, so his hindsight-driven recasting of Nozaki for limitation [8.i] is unsupported and should be rejected.

127. Dr. Bederson does not explain how a POSITA would implement Haitani’s filtering feature in Nozaki’s device other than his say so. Instead, Dr. Bederson conjures a purported need, describes some benefits in generalities (“improve the efficiency”, *see id.* at ¶91), and claims Haitani’s filtering feature “would be a simple addition to the Nozaki device.” *See id.*, ¶93. But describing potential improvements that are accomplished by the claims of the ’848 Patent is the definition of hindsight. Neither Petitioner nor its expert attempts to quantify such “simple” implementation techniques. Implementing an entirely different function on a processor cannot necessarily be expected to be easy.

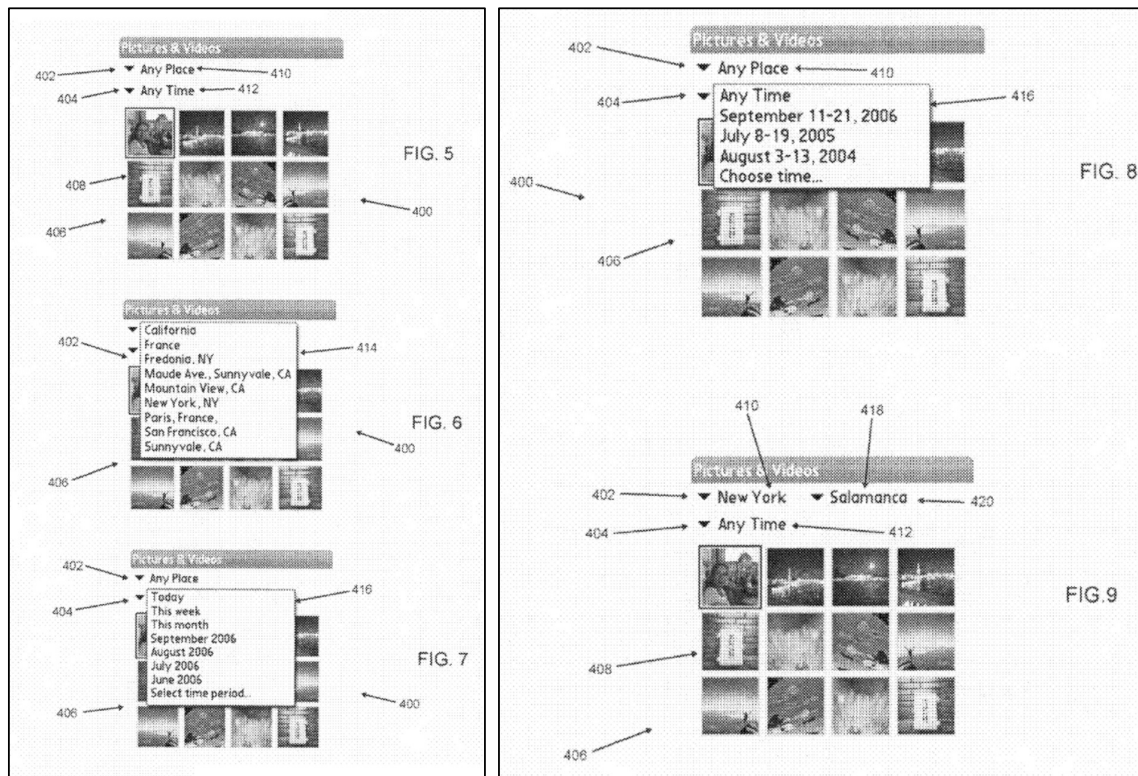
3. *Nozaki in view of Haitani Does Not Disclose Limitation [11.a] of Claim 11.*

128. In my opinion, neither Nozaki nor Haitani, alone or together, disclose a first **and** second reproducing mode for reproducing the image information as claimed in limitation [11.a].

129. Apart from noting that “Nozaki discloses a memory that stores program instructions for execution by a processor,” Dr. Bederson does not cite to any other disclosure of Nozaki for limitation [11.a] and concedes that Nozaki alone does not meet this limitation. *See* Ex. 1005, ¶95. I agree, Nozaki does not disclose limitation [11.a] as it does not disclose a first and second reproducing modes as claimed.

130. Rather, Dr. Bederson focuses his opinions on the various filters disclosed in Haitani and claims that those filters disclose the first and second reproducing modes in limitation [11.a]. *See id.*, ¶¶95-99. I disagree.

131. In sum, the different filters in Haitani are not two separate modes, *i.e.*, a first reproducing mode and a second reproducing mode as claimed. Specifically, Haitani’s filters are not separate operational states of the portable hand-held device 10 that may include a camera 12 to capture still images and movies. *See* Ex. 1007, 2:8-17. Rather, as shown in Figures 5-9 in Haitani reproduced below, a user choosing various filters in Haitani to display images or videos is operating in, at most, a single state—a user is, at all times, in the “Pictures & Video” user interface with the option of selecting one or more drop down menus that filter images or video:



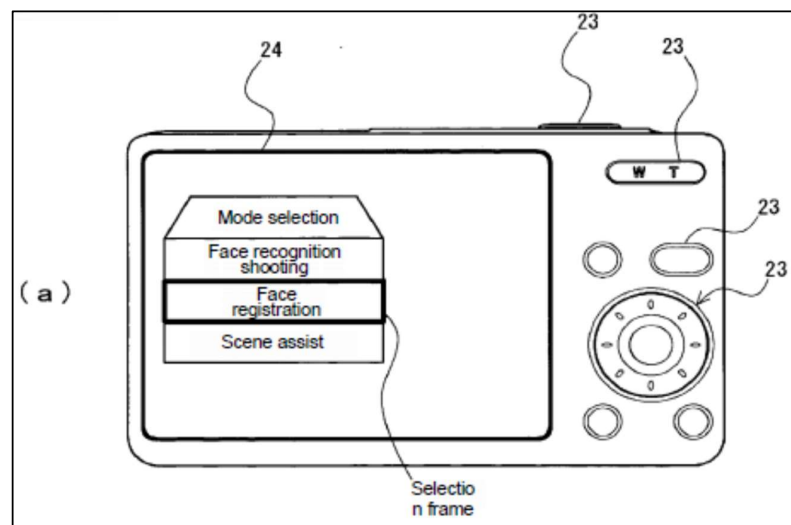
See Ex. 1007, Figs. 5-9. I disagree that a POSITA would have understood that selecting two different filtering options in drop down menus would satisfy the claimed first and second reproducing modes. Samsung's own evidence supports my opinions.

132. **First**, Dr. Bederson's incorrect equating of filters and modes for limitation [11.a] stands in contrast to his understanding of "modes" when discussing Nozaki and the overall content of Nozaki. For example, in discussing limitations [8.g] and [8.h], Dr. Bederson acknowledges that "Nozaki teaches that '[f]irst, the user sets a shooting mode of the electronic camera to a 'face registration mode' by using the operating member 23.'" See EX1005, ¶78 (citing Ex. 1006, Fig. 2

(flowchart step S101), [0062]). Earlier in paragraph [0062], Nozaki states that “[t]he ‘face registration mode’ is a type of shooting mode.” Ex. 1006, [0062].

133. Nozaki further differentiates between “face registration mode” and the “face recognizing shooting mode,” where the latter is a different type of shooting mode selected by the user which performs a different function. *See id.* at [0084]; *see also* Ex. 2031, Bederson Dep. Tr. at 19:19-23 (“Q: So would you agree that Nozaki differentiates between face registration mode and the face-recognizing shooting mode? A. I think that’s right”).

134. For example, when describing Figures 3(a)-(b), Nozaki discusses bringing up a “mode selection screen” on the liquid crystal display 24, and a user can select between a “face registration mode” and a “face recognizing shooting mode” (among other options) on the mode selection screen:



See id. at Figure 3(a), [0063], [0085].

135. Indeed, depending on which mode the user selects, wholly different processing operations are performed by the CPU 26 in Nozaki. *Compare id.* at [0062]-[0083] (“Operations in Face Registration Mode”) and Figure 2 (flow chart relating to the Face Registration Mode) *with* [0084]-[0092] (“Operations in Face Recognizing Shooting Mode”) and Figure 7 (flow chart relating to the Face Recognizing Shooting Mode); *see also* Ex. 2031, Bederson Dep. Tr. at 25:21-26:8 (conceding that “some” processing operations performed by the CPU 26 in the face registration and face recognizing modes of Nozaki are different depending on which mode is selected by the user).

136. Dr. Bederson even recognizes that “Nozaki states that ‘[t]he input button of the operating member 23 accepts switching input, for example, shooting modes of an electronic camera (such as normal shooting mode, regeneration mode, face registration mode, and face recognizing shooting mode).’” *See* Ex. 1005, ¶146 (citing to Ex. 1006, [0049]).

137. In other words, Nozaki uses “mode” consistently with its plain and ordinary meaning as understood by a POSITA—*i.e.*, an operational state that a device has been switched to.

138. **Second**, such a plain and ordinary meaning of the word “mode” is supported by the ’848 Patent. As noted in the Institution Decision (at 6-7), the ’848 Patent describes a “standard reproducing mode,” wherein “all chapters are

sequentially reproduced in an order of smaller chapter ID, irrespective of the chapter importance level set to each chapter.” *Id.* at 9:20–28. The ’848 Patent also describes an “express reproducing mode,” wherein “only the chapters having the chapter importance level ‘3’ or smaller (only the chapters having the importance levels ‘1’ to ‘3’) are reproduced.” *Id.* at 9:29–45. The ’848 Patent further describes a “superexpress reproducing mode,” wherein “only the chapters having the chapter importance level ‘1’ are reproduced.” *Id.* at 9:46–54.

139. Dr. Bederson claims that “the filtered search of Haitani resembles the ‘standard reproducing mode’ and ‘express reproducing mode’ disclosures of the ’848 patent.” *See* Ex. 1005, ¶95. I disagree.

140. The ’848 Patent explains that the user selects between the three different reproducing *modes*—standard, express, superexpress—from a menu. *See* Ex. 1001, 9:20-22 (“as reproduction is performed by selecting as a reproducing mode a ‘standard reproducing mode’ from the menu”), 9:29-30 (“as a user starts reproducing by selecting as the reproducing mode an ‘express reproducing mode’”), 9:46-47 (“as a user starts reproducing by selecting as the reproducing mode a ‘superexpress reproducing mode’”); *see also id.* at Figure 9.

141. A POSITA would understand that this disclosure in the ’848 Patent conveys that a user selects different modes that yield different operations, here, choosing specific chapters and playing back select information. A POSITA would

not understand that this disclosure in the '848 Patent “resembles” the filtering search feature in Haitani, which merely separates data based on user input.

142. **Third**, a POSITA’s understanding of what is a “mode,” as claimed in limitation [11.a], is further supported by extrinsic evidence.

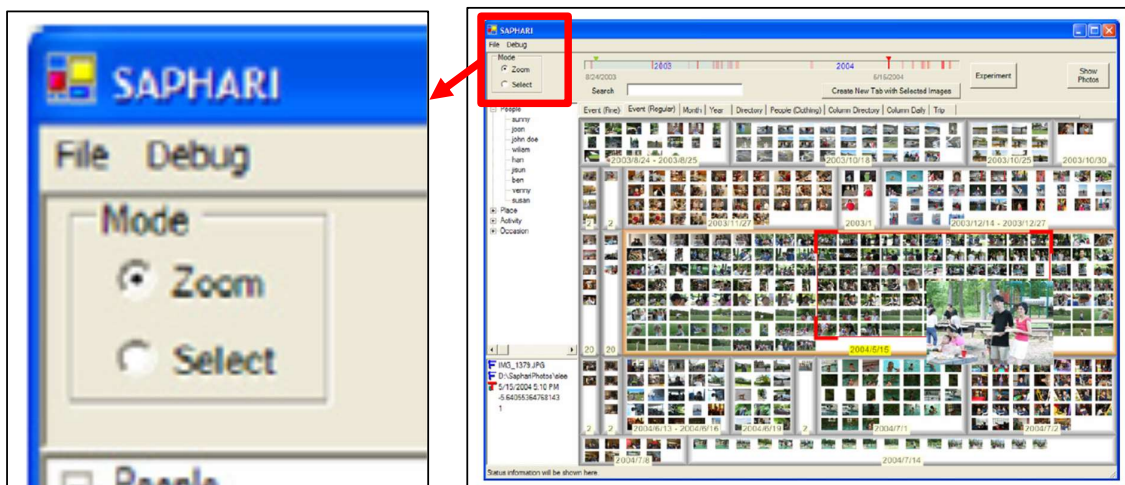
143. For example, multiple dictionary definitions distinguish “filter” and “mode” consistent with the '848 Patent and contrary to Dr. Bederson’s application of filter:

Source	Filter Definition	Mode Definition
PC-Mag (Ex. 2027)	“To select data. Filters use patterns (masks) against which data are compared and only matching data are "passed through," hence the concept of a filter.”	“an operational state that a system has been switched to.”
McGraw-Hill Dictionary of Scientific and Technical Terms, 6 th ed. (2003) (Ex. 2028)	“[Comput Sci] A device or program that separates data or signals in accordance with specified criteria.” Ex. 2028 at 799	“One of several alternative conditions or methods of operation of a device.” (Ex. 2028) at 1357

See also Ex. 2031, Bederson Dep. Tr. at 36:25-39:20 (refusing to offer a specific definition of “filter” but conceding that “Haitani’s use of the word filter may be consistent” with Patent Owner’s proposed definition during the deposition, which was “A filter is something that separates data or signals in accordance with specified criteria”).

144. In fact, even Dr. Bederson has used “mode” in accordance with its plain and ordinary meaning—*i.e.*, an operational state—and not interchangeably with

“filter.” For example, Dr. Bederson relies on his paper describing the “SAPHARI” system as motivation for combining Nozaki and Haitani, both generally and with respect to limitation [8.i]. See Ex. 1005, ¶¶68, 91 (citing to Ex. 1012). However, that publication noted at least two different operational states—selection mode and zoom mode—that were distinct from the “clustering” or filtering teachings in the publication:



See Ex. 1012, Fig. 3, page 20 (“There also were some usability issues with SAPHARI. Some participants did not like the drag-and-drop interaction. Some of them complained about difficulties in marquee-selecting images. Sometimes, users were confused between ‘*selection mode*’ which allows users to select images and ‘*zoom mode*’ which enable users to navigate a zoomable space. Further refinement is needed on these issues.”) (emphasis added). Dr. Bederson’s description of the “selection” and “zoom” modes of the “SAPHARI” system is in contrast to how he described common filtering operations such as performed by Adobe Photoshop

within that same paper. *See id.* at page 4 (“[Adobe Photoshop] has a timeline showing the distribution of photos over time. The timeline has two sliding knobs and users can filter photos by the date they were taken.”); *see also* Ex. 2031, Bederson Dep. Tr. at 6:13-10:6 (testifying as to the graphical user interface (GUI) of the SAPHARI system operating in either the selection or zoom modes depending on which mode selected by the user); *compare id.* (discussion of the selection and zoom modes of the SAPHARI system) *with id.* at 10:8-12:15 (discussion of clustering feature to group photos in the SAPHARI system).

145. **Fourth**, in addition to the above evidence that supports my opinions that Haitani does not disclose limitation [11.a], the disclosure of Haitani *itself* confirms that Dr. Bederson’s unsupported opinion that the filtering feature teaches the first and second reproducing modes should be rejected.

146. Specifically, Haitani draws a clear distinction between filtering and modes—*i.e.*, Haitani knew the difference between the two terms and used them accordingly.

147. For example, Haitani refers to a “review mode” where “the portable device will organize the images into a virtual album.” Ex. 1007, 18:59-60. Haitani states that “[t]he review mode also displays time and location filter menus that allow a user to filter through the images stored by the portable device.” *Id.* at 20:66-21:1. Haitani further discloses that “[i]n a review mode, the portable device allows the

user to create one or more virtual photo albums that use a filter relating to individuals identified in the images. The filter may be related to one person or may be related to multiple people such as a group preset by the user (e.g. a user's immediate family, a filter for high school friends of the user, etc.).” *Id.* at 21:22-28; *see also id.* 21:6-15; Ex. 2031, Bederson Dep. Tr. at 34:23-35:12 (agreeing that Haitani discloses time and location filters used in the context of the “review mode”); *id.* at 40:12-44:8 (agreeing that Figures 5-9 show the device operating in the “review mode”).

148. In addition, Haitani further uses the term “mode” in reference to operational states, noting that “[d]evice 10 may be arranged to operate in one or more position determination modes including, for example, a standalone mode, a mobile station (MS) assisted mode, and/or a MS-based mode.” *See id.* at 29:61-64; *see also id.* at 29:65-30:37 (describing the standalone mode, MS-assisted mode, and MS-based mode), 23:14-16 (describing a “camera mode” where the “device obtains location name information for the area in which the device is located from a remote database using the cellular transceiver”), 33:60-34:26 (describing switching a smartphone from “one mode to another mode (such as switching from a normal ringer mode to a meeting ringer mode” and a normal phone mode and a speakerphone mode).

149. Thus, as admitted by Dr. Bederson, Haitani clearly distinguishes between modes and filters and does not use them interchangeably. *See* Ex. 2031,

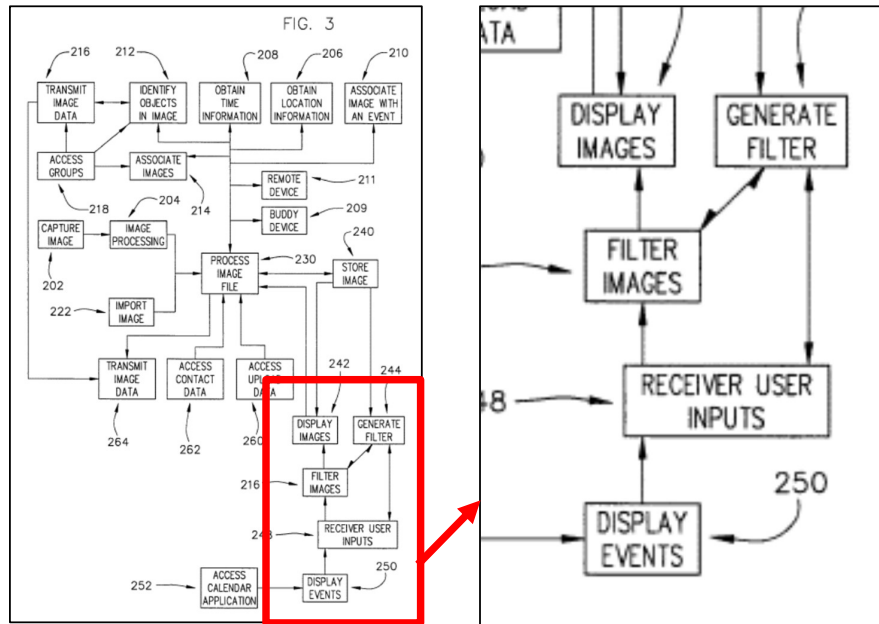
Bederson Dep. Tr. at 49:13-18 (“Q. Okay. Would you agree that Haitani distinguishes between filters and modes? A. I think that’s right in that it describes the graphical user interface, including both filters and using modes.”).

150. In light of all of the evidence, including the passages from Haitani itself, I disagree with Dr. Bederson’s opinions that “[a] POSITA would have understood that these modes of searching for images/videos are discrete from each other, and that using a single filter constitutes a reproducing mode that reproduces a broader range of images/videos for display than reproducing modes that combine the original filter with one or more additional filters” (Ex. 1005, ¶96) and “[a] POSITA would have understood Haitani to teach that a user may combine one or more of these additional filters with the face-recognition filter to employ a different reproducing mode that picks out a more narrowly focused set of images/videos.” *Id.* at ¶98.

151. A POSITA would not treat modes and filters the same—Haitani itself confirms this—and would not conclude that the filters in Haitani teach or disclose the first and second reproducing modes as claimed in limitation [11.a]. Haitani explains various modes and those modes describe different operating states of the portable device whereas the filters do not. At most, Haitani’s filters are an additive feature within a mode (*e.g.*, a review mode) but not a separate mode unto themselves. And Dr. Bederson acknowledges this point when he refers to the filters as “features” not “modes” when discussing limitation [8.i]. *See* Ex. 1005, ¶91 (“a POSITA would

be motivated to add the filtered search and reproduction *feature* from Haitani to the Nozaki device, because adding such a feature would greatly improve the efficiency of searching for photos of registered individuals”) (emphasis added).

152. Nor does Haitani disclose any separate processing occurring in the processing circuit 32 or microprocessor 26 relating to the different filtering operations. Such a fact is not surprising as the different filters are only shown in relation to the same user interface—the Pictures & Videos interface in Figures 5-9. *See* Ex. 2031, Bederson Dep. Tr. at 40:12-44:8 (agreeing that Figures 5-9 show the device operating in the “review mode,” *i.e.*, the interface with pictures and videos). Nor is there any evidence that the portable device operates differently depending on the filtering drop down options chosen as opposed to a user switching between the one of the position determination modes (a standalone mode, a mobile station (MS) assisted mode, and/or a MS-based mode). Indeed, Figure 3 further supports my opinion that different filters are not separate modes (or modes at all):



Ex. 1007, Fig. 3. Rather, Figure 3 shows basic the basic filter feature over a couple of generic boxes but such disclosure does not demonstrate that the filtering feature is the claimed first and second reproducing modes as claimed in limitation [11.a].

153. **Finally**, a POSITA would not have any incentive or motivation to incorporate Haitani’s filtering functionality into Nozaki because doing so would still not disclose the claimed first and second reproducing modes. *See* Ex. 1005, ¶99. Dr. Bederson claims that Nozaki “already suggests sorting the index images” (*id.*), but such an assertion is refuted by his earlier statement that “Nozaki does not explore the ways that the recorded information can be used to tailor the reproduction search process to produce broader or narrower results. *See id.* at ¶67. Dr. Bederson then summarily concludes, without any support, that implementing Haitani into Nozaki “would have required a minimal number of changes to Nozaki’s existing design.”

See id. Dr. Bederson does not identify any changes or modifications to Nozaki that allegedly are within the skill in the art at the time. Dr. Bederson also contends that Haitani may purportedly improve image sorting and displaying, but such a claim is irrelevant as neither Haitani nor the combination of Haitani and Nozaki disclose limitation [11.a]. *See id.*

154. As explained further above, a POSITA would recognize that the Nozaki-Haitani combination, and specifically the filters in Haitani, does not disclose the first and second reproducing modes as claimed in limitation [11.a].

4. *Nozaki in view of Haitani Does Not Disclose Limitation [11.b] of Claim 11.*

155. In my opinion, neither Nozaki nor Haitani disclose a first **and** second reproducing mode for reproducing the image information as claimed in limitation [11.b].

156. Dr. Bederson begins by stating that “As discussed above for limitation [11a], Haitani discloses different modes of reproducing data that use one filter or a combination of filters. *See Supra* Section IX.C.2.” *See* Ex. 1005, ¶100.

157. I understand that to mean that Dr. Bederson incorporated his opinions regarding limitation [11.a] into his opinions for limitation [11.b]. I do the same—I incorporate all of my opinions in limitation [11.a] herein for element [11.b]. In sum, my opinions that a POSITA would recognize that the Nozaki-Haitani combination, and specifically the filters in Haitani, does not disclose the first and second

reproducing modes as claimed in limitation [11.a] is equally applicable to the first and second reproducing mode elements mentioned in limitation [11.b].

158. Limitation [11.b] adds a temporal element to the first and second reproducing modes—“wherein a reproducing time required for reproducing the image information under the first reproducing mode is shorter than a reproducing time required for reproducing the image information under the second reproducing mode.” *See* Ex. 1001, 16:29-33.

159. Dr. Bederson opines that this element is met through Haitani’s filters, stating that:

A POSITA would have understood that the **reproducing time for the first mode (i.e., a “narrower” search that combines multiple filters) would be shorter than a reproducing time for a second mode (i.e., a “broad” search that uses a single filter)** as this limitation recites, because the first mode reproduces fewer image/video files than the second mode, and search results that generate fewer image/video files will encompass a shorter “reproducing time” than search results that generate a larger number of image/video files.

Ex. 1005, ¶100 (emphasis added). I disagree.

160. **First**, as I noted in limitation [11.a], Haitani’s filters are not modes and, thus, the combination of Nozaki and Haitani does not meet limitation [11.b] for that reason alone.

161. **Second**, even if the filters could be read as modes (and they cannot), Dr. Bederson provides nothing but a conclusory opinion regarding the reproduction time for the first and second reproducing modes. Dr. Bederson does not point to any evidence within Haitani or any extrinsic evidence (*e.g.*, something that incorporates the filtering feature of Haitani) to demonstrate that the reproducing time for the first mode would be shorter than the second mode. *See* Ex. 2031, Bederson Dep. Tr. at 55:13-56:3 (“Q. Okay. But there’s nothing expressed in Haitani to indicate the reproduction speed of the filtering operations; agreed? A. As I said, Haitani does disclose displaying more or fewer image or video files in this context. I think it would be abundantly clear to a person of skill that it takes more time to display more items, but I don’t recall if Haitani or **I don’t recall a specific place where Haitani expressly says that it would take more time to display more items.**”) (objection omitted) (emphasis added). There is nothing in Haitani to indicate any reproduction speed of the filtering operations, whether for one or multiple filters, let alone in the specifically claimed arrangement, but Dr. Bederson’s opinions ignore that fact and are not supported by evidence from Haitani.

162. In fact, Dr. Bederson’s hindsight driven analysis is laid bare by his assignment of the narrower search as the first mode and the broader search as the second mode. Dr. Bederson’s assertion that “it takes more time to display more items” is incorrect as it doesn’t consider the totality of the filtering and display

process. The time taken to filter data and display results is dependent on many factors including the type of data and how it's structured and indexed and cannot simplistically be attributed to the number of data items ultimately displayed as per Dr. Bederson's reductionist argument. Thus, Dr. Bederson is wrong when he testified "it would be abundantly clear to a person of skill that it takes more time to display more items."

163. Moreover, Dr. Bederson's reliance on the reproduction modes in the '848 Patent (*e.g.*, the standard, express, superexpress reproducing modes) do not support his opinions for the same reasons that I set forth in limitation [11.a]. *See* Ex. 1005, ¶100. Namely, a POSITA would understand that the disclosure in the '848 Patent for the three different reproduction modes conveys that a user selects different modes that yield different operations such as choosing specific chapters and playing back select information. A POSITA would not understand that this disclosure in the '848 Patent as being "consistent" with the filtering search feature in Haitani as claimed by Dr. Bederson (Ex. 1005, ¶100), which merely separates data based on user input.

164. In sum, a POSITA would recognize that the Nozaki-Haitani combination, and specifically the filters in Haitani, does not disclose the first and second reproducing modes as claimed in limitation [11.b].

5. *Nozaki in view of Haitani Does Not Disclose Limitation [11.c] of Claim 11.*

165. In my opinion, neither Nozaki nor Haitani disclose a first **and** second reproducing mode for reproducing the image information as claimed in limitation [11.c].

166. Dr. Bederson begins by stating that “As discussed above for limitations [11a] and [11b], Haitani discloses different modes of reproducing data that use one filter or a combination of filters, including a mode using one filter ‘cover[ing] a broad range’ and a mode adding a second filter that reproduces a ‘narrower’ range of images/videos.” *See* Ex. 1005, ¶101.

167. I understand that to mean that Dr. Bederson incorporated his opinions regarding limitations [11.a] and [11.b] into his opinions for limitation [11.c]. I do the same—I incorporate all of my opinions in limitations [11.a] and [11.b] herein for element [11.c]. In sum, my opinions that a POSITA would recognize that the Nozaki-Haitani combination, and specifically the filters in Haitani, does not disclose the first and second reproducing modes as claimed in limitations [11.a] and [11.b] are equally applicable to the first and second reproducing mode elements mentioned in limitation [11.c].

168. Limitation [11.c] adds a limitation related to the image information in the first and second reproducing modes—“the image information reproduced under the second mode includes the image information reproduced under the first

reproducing mode and other of the image information not reproduced under the first reproducing mode.” *See* Ex. 1001, 16:33-37.

169. Dr. Bederson opines that this element is met through Haitani’s filters, stating that:

A POSITA would have understood that the images/videos reproduced in the “broad” second mode that uses a single search term (e.g., only face recognizing data) would include the images/videos reproduced in the “narrower” first mode (e.g., face recognizing data plus a date/time range) as well as other images/videos that the first mode did not cause to be reproduced, as this limitation recites.

Ex. 1005, ¶101. I disagree.

170. **First**, as I noted in limitations [11.a] and [11.b], Haitani’s filters are not modes and, thus, the combination of Nozaki and Haitani does not meet limitation [11.b] for that reason alone.

171. **Second**, even if the filters could be read as modes (and they cannot), Dr. Bederson provides nothing but a conclusory opinion regarding the content of the first and second reproducing modes as claimed. Dr. Bederson does not point to any evidence within Haitani or extrinsic evidence (e.g., something that incorporates the filtering feature of Haitani) to demonstrate that the purportedly broader second reproducing mode includes images/videos in the first reproducing mode plus other image information not in the first mode as claimed. The narrower filter identified by

Dr. Bederson comprising two filters—a face recognizing data plus a date/time range—could comprise the entire universe of face-recognition images in the broader filter, *i.e.*, all of the stored images were taken of a single person on a single day (*e.g.*, Christmas Day). In that hypothetical, which Haitani does not preclude, the broader filter would not have any additional or other images/videos that are not in the narrower filter—there would be complete overlap between the two sets of images. Dr. Bederson’s opinions ignore that fact and are not supported by evidence from Haitani. *See* Ex. 2031, Bederson Dep. Tr. at 61:4-17 (agreeing that Haitani does not preclude the complete overlap situation).

172. In sum, a POSITA would recognize that the Nozaki-Haitani combination, and specifically the filters in Haitani, does not disclose the first and second reproducing modes as claimed in limitation [11.c].

173. Accordingly, it is my opinion that the combination of Nozaki and Haitani do not disclose each element for challenged claim 11.

6. *Nozaki in view of Haitani Does Not Disclose Limitation [12.a] of Claim 12.*

174. In my opinion, neither Nozaki nor Haitani disclose a first **and** second reproducing mode, let alone a third reproducing mode, for reproducing the image information as claimed in limitation [12.a].

175. Dr. Bederson begins by stating that “As an initial matter, and as discussed above in limitation [11a], Nozaki and Haitani both disclose a memory that

stores program instructions for execution by a processor. *See Supra* Section IX.C.2. Also, as discussed above for limitations [11a] and [11b], Haitani discloses the use of different reproducing modes that use a filter or a combination of filters (*e.g.*, filters based on face-recognition data, date/time, location, or events) to search for and reproduce a set or subset of image/video files. *See Supra* Section IX.C.2 and IX.C.3.” *See* Ex. 1005, ¶103.

176. I understand that to mean that Dr. Bederson incorporated his opinions regarding limitations [11.a] and [11.b] into his opinions for limitation [12.a]. I do the same—I incorporate all of my opinions in limitations [11.a] and [11.b] herein for element [12.a]. In sum, my opinions that a POSITA would recognize that the Nozaki-Haitani combination, and specifically the filters in Haitani, does not disclose the first and second reproducing modes as claimed in limitations [11.a] and [11.b] are equally applicable to the first and second reproducing mode elements and the third reproducing mode mentioned in limitation [12.a].

177. Limitation [12.a] adds a third reproducing mode to the first and second reproducing modes from claim 11—“wherein the memory further stores instructions that, when executed by the processor, cause the processor to: control the reproduction of the image information in the reproducing mode set from one of the first reproducing mode, the second reproducing mode, and a third reproducing mode.” *See* Ex. 1001, 16:41-44.

178. Dr. Bederson opines that this element is met through Haitani's filters, stating that:

It is my opinion that a POSITA would have understood that Haitani discloses three search modes that use different filters, and that will generate different sets of image/video files. For example, a first mode might use face registration data as a filter, a second mode might add date/time as an additional filter, and a third mode might further add a third filter (e.g., location or events). A POSITA would have known that each mode would generate broader or narrower results. Each mode would correspond to a mode recited in this limitation.

Ex. 1005, ¶103. I disagree.

179. **First**, as I noted in limitations [11.a] and [11.b], Haitani's filters are not modes and, thus, the combination of Nozaki and Haitani does not meet limitation [12.a] for that reason alone.

180. **Second**, even if the filters could be read as modes (and they cannot), Dr. Bederson provides nothing but a conclusory opinion regarding what could constitute the first, second, and third reproducing modes as claimed. Dr. Bederson does not point to any evidence within Haitani or extrinsic evidence (e.g., something that incorporates the filtering feature of Haitani) to demonstrate that the purportedly broadest filter generates different sets of images/videos than the narrower second or third filters. For example, the broadest filter (comprising face-recognition images) could comprise all pictures taken of the same person on the same day in the same

location (*e.g.*, on Christmas Day at home). In that hypothetical, which Haitani does not preclude, the broader filter would not have any additional or other images/videos that are not in the narrower two filters (second as date/time, third as to location)—there would be complete overlap between the three sets of images. Dr. Bederson’s opinions ignore that fact and are not supported by evidence from Haitani.

181. Moreover, Dr. Bederson’s reliance on the reproduction modes in the ’848 Patent (*e.g.*, the standard, express, superexpress reproducing modes) do not support his opinions for the same reasons that I set forth in limitation [11.a]. *See* Ex. 1005, ¶103. Namely, a POSITA would understand that the disclosure in the ’848 Patent for the three different reproduction modes conveys that a user selects different modes that yield different operations such as choosing specific chapters and playing back select information. A POSITA would not understand that this disclosure in the ’848 Patent as being “consistent” with the filtering search feature in Haitani as claimed by Dr. Bederson (Ex. 1005, ¶103), which merely separates data based on user input.

182. In sum, a POSITA would recognize that the Nozaki-Haitani combination, and specifically the filters in Haitani, does not disclose the first and second reproducing modes as claimed in limitation [12.a].

7. *Nozaki in view of Haitani Does Not Disclose Limitation [12.b] of Claim 12.*

183. In my opinion, neither Nozaki nor Haitani disclose a first **and** second reproducing mode, let alone a third reproducing mode, for reproducing the image information as claimed in limitation [12.b].

184. Dr. Bederson begins by stating that “As discussed above in limitation [12a], a POSITA would have understood Haitani to disclose at least three reproducing modes, for example if each mode adds another filter to the filter(s) of the mode preceding it. *See Supra* Section IX.D.2.” *See* Ex. 1005, ¶104.

185. I understand that to mean that Dr. Bederson incorporated his opinions regarding limitation [12.a] into his opinions for limitation [12.b]. I do the same—I incorporate all of my opinions in limitation [12.a] herein for element [12.b]. In sum, my opinions that a POSITA would recognize that the Nozaki-Haitani combination, and specifically the filters in Haitani, does not disclose the first, second, or third reproducing modes as claimed in limitation [12.a] is equally applicable to the first, second, and third reproducing mode elements mentioned in limitation [12.b].

186. Limitation [12.b] adds a temporal element to the first and second reproducing modes—“wherein a reproducing time required for reproducing the image information under the third reproducing mode is longer than the reproducing time required for reproducing the image information under the second reproducing mode.” *See* Ex. 1001, 16:45-49.

187. Dr. Bederson opines that this element is met through Haitani's filters, stating that:

A POSITA would have known that each mode would generate broader or narrower results, with the broadest mode being a "third" mode having the characteristics recited in this limitation, i.e., a reproducing time longer than the second mode.

Ex. 1005, ¶104. I disagree.

188. **First**, as I noted in limitations [11.a], [11.b], and [12.a], Haitani's filters are not modes and, thus, the combination of Nozaki and Haitani does not meet limitation [12.b] for that reason alone.

189. **Second**, even if the filters could be read as modes (and they cannot), Dr. Bederson provides nothing but a conclusory opinion regarding the reproduction time for the second and third reproducing modes. Dr. Bederson does not point to any evidence within Haitani or extrinsic evidence (*e.g.*, something that incorporates the filtering feature of Haitani) to demonstrate that the reproducing time for the third reproduction mode is longer than the second reproducing mode. There is nothing in Haitani to indicate any reproduction speed of the filtering operations, whether for one or multiple filters, let alone in the specifically claimed arrangement. Dr. Bederson's opinions ignore that fact and are not supported by evidence from Haitani.

190. In fact, Dr. Bederson admitted that, within claim 12, he is not referring to Haitani's filters consistently. Specifically, Dr. Bederson stated that the

arrangement of filters for claim element [12.b] would have to be *different* than the arrangement of filters for claim element [12.a]. *See* Ex. 2031, Bederson Dep. Tr. at 65:11-24 (“The three modes I gave examples for regarding limitation 12(a) would actually have to be reversed to meet the limitation 12(b). So the longer one, the third mode, would be only one filter, not all three filters. I just want to make it clear that filters 1, 2 and 3 from 12(a) were examples that met 12(a), but if you want to use those same examples for 12(b), then the third mode would have to apply to the example where there was only one filter, not all three filters.”), 65:25-66:7 (“Q. Okay. So in 12(a), you characterize the first mode as a face registration data, but that would have to be the third mode in element 12(b)? A. If we wanted to use those particular examples in 12(b), then, yes, that’s right.”).

191. I disagree with Dr. Bederson’s shifting assignment of filters to drive his hindsight analysis. Dr. Bederson’s assertion that “it takes more time to display more items” is incorrect as it doesn’t consider the totality of the filtering and display process. The time taken to filter data and display results is dependent on many factors including the type of data and how it’s structured and indexed and cannot simplistically be attributed to the number of data items ultimately displayed as per Dr. Bederson’s reductionist argument. Thus, Dr. Bederson is wrong when he testified “it would be abundantly clear to a person of skill that it takes more time to display more items.”

192. Moreover, Dr. Bederson's reliance on the reproduction modes in the '848 Patent (*e.g.*, the standard, express, superexpress reproducing modes) do not support his opinions for the same reasons that I set forth in limitation [11.a]. *See* Ex. 1005, ¶104. Namely, a POSITA would understand that the disclosure in the '848 Patent for the three different reproduction modes conveys that a user selects different modes that yield different operations such as choosing specific chapters and playing back select information. A POSITA would not understand that this disclosure in the '848 Patent as being "consistent" with the filtering search feature in Haitani as claimed by Dr. Bederson (Ex. 1005, ¶104), which merely separates data based on user input.

193. In sum, a POSITA would recognize that the Nozaki-Haitani combination, and specifically the filters in Haitani, does not disclose the first and second reproducing modes as claimed in limitation [12.b].

194. Accordingly, it is my opinion that the combination of Nozaki and Haitani do not disclose each element for challenged claim 12.

8. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Haitani to Disclose Limitations [13.h]-[13.j] of Claim 13*

195. In my opinion, a POSITA would not have found it obvious to combine Nozaki with Haitani to comprise a processor configured according to limitations [13.h]-[13.j].

196. Dr. Bederson begins his opinions by cross referencing Section IX.B.10 among other sections. *See* Ex. 1005, ¶¶113-115. I understand that to mean that Dr. Bederson incorporated his opinions regarding limitation [8.i] for the Nozaki-Haitani combination into his opinions for limitations [13.h]-[13.j] for the Nozaki-Haitani combination. In addition, in limitations [13.h]-[13.j], Dr. Bederson references Haitani’s filters and forwards additional, unsupported and hindsight-driven opinions regarding why a POSITA would incorporate the Haitani filters into Nozaki to teach limitations [13.h]-[13.j].

197. I do the same—I incorporate all of my opinions in limitation [8.i] and Section IX(A)(1) herein for elements [13.h]-[13.j]. In sum, my opinions that a POSITA would not be motivated to combine Nozaki with Haitani to teach element [8.i] and Section IX(A)(1) are equally applicable to limitations [13.h]-[13.j]. Specifically, a POSITA would not be motivated to incorporate the filters of Haitani into Nozaki.

198. Accordingly, it is my opinion that a POSITA would not be motivated to combine Nozaki with Haitani to teach limitations [13.h]-[13.j].

9. *Nozaki in view of Haitani Does Not Disclose Limitations [16.a]-[16.c] of Claim 16*

199. For limitation [16.a], Dr. Bederson only cross-references his arguments for claim element [11.a] in Section IX.C.2 of his declaration. *See* Ex. 1005, ¶117 (“*See Supra* Section IX.C.2.”). Dr. Bederson does not provide any additional

arguments or opinions for limitation [16.a]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [11.a] are equally applicable to claim element [16.a] and I incorporate them herein by reference. Additionally, Dr. Bederson completely glosses over the requirements of limitation [16.a] with his sole cross-reference to claim element [11.a] as support for limitation [16.a]. Limitation [16.a] requires the reproducer to selectively and *sequentially* reproduce the image information picked out based on the predetermined condition in a reproducing mode set from one of a first reproducing mode and a second reproducing mode....” Dr. Bederson fails to explain this sequential reproduction in reference to limitation 11[a] for element 16[a]. This failure of proof is fatal to Petitioner’s and Dr. Bederson’s analysis for Claim 16.

200. For limitation [16.b], Dr. Bederson only cross-references his arguments for claim element [11.b] in Section IX.C.3 of his declaration. *See* Ex. 1005, ¶118 (“*See Supra* Section IX.C.3.”). Dr. Bederson does not provide any additional arguments or opinions for limitation [16.b]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [11.b] are equally applicable to claim element [16.b] and I incorporate them herein by reference.

201. For limitation [16.c], Dr. Bederson only cross-references his arguments for claim element [11.c] in Section IX.C.2 of his declaration. *See* Ex. 1005, ¶119

(“*See Supra* Section IX.C.4.”). Dr. Bederson does not provide any additional arguments or opinions for limitation [16.c]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [11.c] are equally applicable to claim element [16.c] and I incorporate them herein by reference.

202. In sum, it is my opinion that the combination of Nozaki and Haitani do not disclose each element for challenged claim 16.

10. Nozaki in view of Haitani Does Not Disclose Limitations [17.a]-[17.b] of Claim 17

203. For limitation [17.a], Dr. Bederson only cross-references his arguments for claim element [12.a] in Section IX.D.2 of his declaration. *See* Ex. 1005, ¶121 (“*See Supra* Section IX.D.2.”). Dr. Bederson does not provide any additional arguments or opinions for limitation [17.a]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [12.a] are equally applicable to claim element [17.a] and I incorporate them herein by reference. Additionally, Dr. Bederson completely glosses over the requirements of limitation [17.a] with his sole cross-reference to claim element [12.a] as support for limitation [17.a]. Limitation [17.a] requires the reproducer to selectively and *sequentially* reproduce the image information picked out based on the predetermined condition in a reproducing mode set from one of a first reproducing mode and a second reproducing mode....” Dr. Bederson fails to explain this sequential

reproduction in reference to limitation 11[a] for element 17[a]. This failure of proof is fatal to Petitioner's and Dr. Bederson's analysis for Claim 17.

204. For limitation [17.b], Dr. Bederson only cross-references his arguments for claim element [12.b] in Section IX.D.3 of his declaration. *See* Ex. 1005, ¶122 (“*See Supra* Section IX.D.3.”). Dr. Bederson does not provide any additional arguments or opinions for limitation [17.b]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [12.b] are equally applicable to claim element [17.b] and I incorporate them herein by reference.

205. In sum, it is my opinion that the combination of Nozaki and Haitani do not disclose each element for challenged claim 17.

11. A POSITA Would Not Have Found It Obvious To Combine Nozaki with Haitani to Disclose Limitations [18.g]-[18.i] of Claim 18

206. In my opinion, a POSITA would not have found it obvious to combine Nozaki with Haitani to comprise a processor configured according to limitations [18.g]-[18.i].

207. Dr. Bederson opinions for limitations [18.g]-[18.i] only cross references Sections IX.E.9 through IX.E.11. *See* Ex. 1005, ¶¶130-132. I understand that to mean that Dr. Bederson incorporated his opinions regarding limitations

[13.h]-[13.j] for the Nozaki-Haitani combination into his opinions for limitations [18.g]-[18.i] for the Nozaki-Haitani combination.

208. I do the same—I incorporate all of my opinions in limitations [13.h]-[13.j]—which themselves incorporated my opinions from limitation [8.i] and Section III(A)(1)—herein for elements [18.g]-[18.i]. In sum, my opinions that a POSITA would not be motivated to combine Nozaki with Haitani to teach element [8.i] and Section III(A)(1) are equally applicable to limitations [18.g]-[18.i]. Specifically, a POSITA would not be motivated to incorporate the filters of Haitani into Nozaki.

209. Accordingly, it is my opinion that a POSITA would not be motivated to combine Nozaki with Haitani to teach limitations [18.g]-[18.i].

12. Nozaki in view of Haitani Does Not Disclose Limitations [19.a]-[19.c] of Claim 19

210. For limitation [19.a], Dr. Bederson only cross-references his arguments for claim element [11.a] in Section IX.C.2 of his declaration. *See* Ex. 1005, ¶134 (“*See Supra* Section IX.C.2.”). Dr. Bederson does not provide any additional arguments or opinions for limitation [19.a]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [11.a] are equally applicable to claim element [19.a] and I incorporate them herein by reference. Additionally, Dr. Bederson completely glosses over the requirements of limitation [19.a] with his sole cross-reference to claim element [11.a] as support for

limitation [19.a]. Limitation [19.a] requires the reproducer to selectively and *sequentially* reproduce the image information picked out based on the predetermined condition in a reproducing mode set from one of a first reproducing mode and a second reproducing mode....” Dr. Bederson fails to explain this sequential reproduction in reference to limitation [11.a] for element [19.a]. This failure of proof is fatal to Petitioner’s and Dr. Bederson’s analysis for Claim 19.

211. For limitation [19.b], Dr. Bederson only cross-references his arguments for claim element [11.b] in Section IX.C.3 of his declaration. *See* Ex. 1005, ¶135 (“*See Supra* Section IX.C.3.”). Dr. Bederson does not provide any additional arguments or opinions for limitation [19.b]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [11.b] are equally applicable to claim element [19.b] and I incorporate them herein by reference.

212. For limitation [19.c], Dr. Bederson only cross-references his arguments for claim element [11.c] in Section IX.C.2 of his declaration. *See* Ex. 1005, ¶119 (“*See Supra* Section IX.C.4.”). Dr. Bederson does not provide any additional arguments or opinions for limitation [19.c]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [11.c] are equally applicable to claim element [19.c] and I incorporate them herein by reference.

213. In sum, it is my opinion that the combination of Nozaki and Haitani do not disclose each element for challenged claim 19.

13. Nozaki in view of Haitani Does Not Disclose Limitations [20.a]-[20.b] of Claim 20

214. For limitation [20.a], Dr. Bederson only cross-references his arguments for claim element [12.a] in Section IX.D.2 of his declaration. *See* Ex. 1005, ¶138 (“*See Supra* Section IX.D.2.”). Dr. Bederson does not provide any additional arguments or opinions for limitation [20.a]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [12.a] are equally applicable to claim element [20.a] and I incorporate them herein by reference. Additionally, Dr. Bederson completely glosses over the requirements of limitation [20.a] with his sole cross-reference to claim element [12.a] as support for limitation [20.a]. Limitation [20.a] requires the reproducer to selectively and *sequentially* reproduce the image information picked out based on the predetermined condition in a reproducing mode set from one of a first reproducing mode and a second reproducing mode....” Dr. Bederson fails to explain this sequential reproduction in reference to limitation [12.a] for element [20.a]. This failure of proof is fatal to Petitioner’s and Dr. Bederson’s analysis for Claim 20.

215. For limitation [20.b], Dr. Bederson only cross-references his arguments for claim element [12.b] in Section IX.D.3 of his declaration. *See* Ex. 1005, ¶139 (“*See Supra* Section IX.D.3.”). Dr. Bederson does not provide any additional

arguments or opinions for limitation [20.b]. Accordingly, my opinions as to why the combination of Nozaki in view of Haitani does not disclose claim element [12.b] are equally applicable to claim element [20.b] and I incorporate them herein by reference.

216. In sum, it is my opinion that the combination of Nozaki and Haitani do not disclose each element for challenged claim 20.

B. Ground 2: Nozaki in view of Haitani in further view of Graham Does Not Render Claim 84 Obvious

217. For Ground 2, neither the Petitioner nor Dr. Bederson demonstrate that Nozaki alone anticipates challenged claim 84. In an attempt to fill in the gaps of the deficiencies of Nozaki, Petitioner and Dr. Bederson have failed to show that it would have been obvious to combine Nozaki with Haitani and/or Graham. Even if combining Nozaki with Haitani and Graham was obvious, Petitioner and Dr. Bederson have failed to show that the combination of Nozaki, Haitani, and Graham disclose each element of challenged claim 84.

1. A POSITA Would Not Have Found It Obvious To Combine Nozaki, Haitani, and Graham for Claim 84

218. Ground 2 initially fails because Dr. Bederson has stated only vague, conclusory, and unsupported reasons to combine Nozaki, Haitani, and Graham to render obvious challenged claim 84. *See* Ex. 1005, Section X(A).

219. Dr. Bederson claims that “Graham, Nozaki and Haitani are compatible with and complementary to each other, and in my opinion a POSITA would have been motivated to combine them for this additional reason.” *See* Ex. 1005, ¶141. I disagree.

220. Dr. Bederson focuses on Haitani’s search filters but, as I explained in Section IX(A), Haitani’s filters are not modes and do not teach or disclose the first, second, or third reproducing modes of challenged claims 11-12, 16-17, and 19-20. Thus, a POSITA would not be motivated combine Haitani with Nozaki.

221. Regarding Graham, Dr. Bederson opines not that a POSITA would have allegedly found it obvious to combine Graham with the Nozaki-Haitani combination but rather just with Nozaki, stating “A POSITA would have also found it obvious to modify the Nozaki device to incorporate the disclosures in Graham, which are directed to searching for and reproducing specific segments within individual video files.” *See* Ex. 1005, ¶141. But Dr. Bederson provides no support for this statement other than his say so. Dr. Bederson presumes that Graham’s alleged method of segmenting videos could be compatible with Nozaki alone (not the Nozaki-Haitani combination that Graham is being added to) but, again, there is no support for such a statement. *See id.*

222. It is my opinion that the design requirements for Nozaki, Haitani, and Graham are substantially different. In addition, a POSITA would not be motivated

to combine the teachings of Nozaki, Haitani, and Graham because they are directed to solving different problems and use different structures to solve these problems. Dr. Bederson has not considered the three references as a whole and has not accounted for these differences. Instead, Dr. Bederson selected portions of each reference and used hindsight to assemble a new system without accounting for the different objectives and goals of the systems in Nozaki, Haitani, and Graham.

223. Dr. Bederson also does not explain how a POSITA would implement the video-segmenting from Graham in a portable device like Nozaki, let alone the combination of Nozaki-Haitani that Graham is being added to. Instead, Dr. Bederson conjures a purported need, describes some benefits in generalities (“improve the efficiency”), and claims Graham’s video-segmenting methods “could have easily been implemented in the Nozaki device.” But describing potential improvements that are accomplished by the claims of the ’848 Patent is the definition of hindsight. Neither Petitioner nor its expert attempts to quantify such “easy” implementation techniques. Implementing an entirely different function on a processor cannot necessarily be expected to be easy.

224. For all of the foregoing reasons, it is my opinion that a POSITA would not combine Nozaki, Haitani, and Graham.

2. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Haitani to Disclose Limitation [84.c.vii] of Claim 84*

225. In my opinion, a POSITA would not have found it obvious to combine Nozaki with Haitani to comprise a processor that can “selectively reproduce the recorded image which includes the registered specific person” as claimed in limitation [84.c.vii].

226. Dr. Bederson’s opinions for limitation [84.c.vii] only cross references Section IX.B.10. *See* Ex. 1005, ¶154. I understand that to mean that Dr. Bederson incorporated his opinions regarding limitation [8.i] for the Nozaki-Haitani combination into his opinions for limitation [84.c.vii] for the Nozaki-Haitani combination.

227. I do the same—I incorporate all of my opinions in limitation [8.i] and Section III(A)(1) herein for element [84.c.vii]. In sum, my opinions that a POSITA would not be motivated to combine Nozaki with Haitani to teach element [8.i] and Section IX(A)(1) are equally applicable to limitation [84.c.vii]. Specifically, a POSITA would not be motivated to incorporate the filters of Haitani into Nozaki.

228. Accordingly, it is my opinion that a POSITA would not be motivated to combine Nozaki with Haitani to teach limitation [84.c.vii].

3. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Haitani to Disclose Limitation [84.d] of Claim 84*

229. In my opinion, a POSITA would not have found it obvious to combine Nozaki with Haitani to disclose “a touch panel adhered to a screen of the display, wherein the first setting mode and the second setting mode are each selected using the touch panel” as claimed in limitation [84.d].

230. Dr. Bederson concedes that Nozaki does not disclose this limitation in full. *See* Ex. 1005, ¶157.

231. Dr. Bederson notes that Haitani discloses a touch panel and opines that “A POSITA would have known—with or without the disclosures in Haitani—that Nozaki’s display and operating member configuration could be modified to be a touch-screen interface. Such a modification would have been a matter of design choice, and would have required a simple substitution within the skill of a POSITA.” *See id.* I disagree.

232. Haitani’s disclosure of a touch panel was in the context of a portable handheld device, such as a cell phone. *See* Ex. 1006, 2:9-11. That is not surprising considering that the assignee of Haitani is Qualcomm, one of the—if not the—biggest cell phone developers when the application for Haitani was filed (March 22, 2007). However, there is nothing to suggest that a POSITA would use a touch screen application in Nozaki. Nozaki is an electronic camera, which has a priority date tracing back to November 25, 2005 (almost an entire year earlier than Haitani’s

earliest date of December 5, 2006), and its applicant was Nikon Corporation, a leader in digital camera, not cell or smartphone technology. Indeed, it appears that Nikon did not incorporate touch screen technology into its digital cameras until early 2009, well after the priority date of the '848 Patent (May 19, 2008). *See* Ex. 2025, <https://www.nikonusa.com/press-room/nikon-unveils-new-s230-touch-s>.

233. In addition, a POSITA would not be motivated to combine the touch panel of Haitani into Nozaki because they are directed to solving different problems and use different structures to solve these problems. *See* Ex. 1005, ¶159. Dr. Bederson has not considered the references as a whole and has not accounted for these differences. Instead, Dr. Bederson selected portions of each reference and used hindsight to assemble a new system without accounting for the different objectives and goals of the systems in Nozaki and Haitani. Dr. Bederson's claim that such a combination would be "more intuitive for users" is pure speculation and further hindsight that is not supported by any evidence.

234. Accordingly, it is my opinion that a POSITA would not be motivated to combine Nozaki with Haitani to teach limitation [84.d].

4. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Graham to Disclose Limitation [84.h.i] of Claim 84*

235. In my opinion, a POSITA would not have found it obvious to combine Nozaki with Graham to comprise a processor that "automatically sets a plurality of

sections corresponding to the video information of the scene” as claimed in limitation [84.h.i].

236. Dr. Bederson concedes that Nozaki does not disclose this limitation and uses Graham to attempt to fill in the gaps. *See* Ex. 1005, ¶¶165-167.

237. But Dr. Bederson errs in attempting to combine Graham to only Nozaki, not the Nozaki-Haitani combination (or Nozaki alone within that combination) that Dr. Bederson relies on to disclose limitations [84.pre]-[84.h] and [84.i]. *Compare id. with id.* at ¶¶147-164, 169. In other words, Dr. Bederson uses two different two-reference combinations (Nozaki-Haitani and Nozaki-Graham) to purportedly disclose each of the limitations of claim 84 but does not provide any reasoning or motivation that a POSITA would look to combine all three references to disclose claim 84 in full. Dr. Bederson’s piecemeal analysis should be rejected for this reason alone.

238. Moreover, Dr. Bederson provides nothing but improper hindsight to combine Graham with only Nozaki (not the Nozaki-Haitani combination). *See id.* at ¶¶165-167.

239. Although Graham discloses a method of “retrieving and displaying multimedia information” such as “video information” wherein “thumbnail images” of “video keyframes” are “extracted from the video information... at various points

in time using a specified sampling rate,” Graham is solving a wholly different problem with different hardware than Nozaki. *See* Ex. 1008, [0060]-[0062], [0088].

240. Particularly, Graham sought to solve problems associated with reading large quantities of electronic information, presenting a solution that would allow a user to read an electronic document horizontally rather than vertically:

[0013] Given the vast number of electronic documents, readers of electronic documents are increasingly being called upon to assimilate vast quantities of information in a short period of time. To meet the demands placed upon them, readers find they must read electronic documents “horizontally” rather than “vertically,” i.e., they must scan, skim, and browse sections of interest in one or more electronic documents rather than read and analyze a single document from start to end. While tools exist which enable users to “horizontally” read or skim electronic documents containing text/image information (e.g., the reading tool described in U.S. Non-Provisional patent application Ser. No. 08/995,616), conventional tools cannot be used to “horizontally” read or skim multimedia documents which may contain audio information, video information, and other types of information. None of the multimedia tools described above allow users to “horizontally” read or skim a multimedia document.

[0014] In light of the above, there is a need for techniques that allow users to skim or read a multimedia document “horizontally.” Techniques that allow users to view, analyze, and navigate multimedia information stored in multimedia documents are desirable.

See Ex. 1008, [0013]-[0014]; *see also id.* at [0060], [0067] (also discussing the GUI allows a user to “horizontally” read or skim multimedia documents).

241. Moreover, Graham discloses searching for information by text or words, not by face information. *See, e.g., id.* at [0018], [0123]-[0142], claim 15.

242. Dr. Bederson’s reason for combining Graham with Nozaki alone is entirely conclusory. *See* Ex. 1005, ¶167. Dr. Bederson argues: “A POSITA would have recognized that the method of reproducing video information disclosed in Graham would be compatible with the Nozaki device because, for example, the vertical display setup in Graham is similar to the vertical listing of ‘face recognizing data’ shown on the lower part of the ‘detailed information screen’ (Figure 5) in Nozaki. A POSITA would have recognized that the Nozaki device could display the video keyframes of Graham as part of its ‘regeneration mode’ for video files, and a POSITA would have been motivated to desired portion of a video file.” *See id.* I disagree.

243. Dr. Bederson points to nothing in Graham that would suggest its video keyframing methodology is compatible with Nozaki. Nor is the vertical setup in Graham similar to the information in Figure 5 of Nozaki. Graham discloses a wholly different interface, showing numerous thumbnails associated with a video image that have text/words associated with a thumbnail image whereas Nozaki shows a thumbnail of person’s face with no text associated with the video that the thumbnail

represents; rather, Nozaki provides information associated with the recording details (e.g., frame rate, focus, shooting mode, etc.).

244. Finally, I disagree with Dr. Bederson's last two statements in paragraph 167 of his declaration. While Graham is attempting to solve problems associated with users "assimilate[ing] vast quantities of information in a short period of time," as discussed above, Graham's solution is wholly different than Nozaki's disclosure associated with storing images and video files. *See* Ex. 1005, ¶167 (citing Ex. 1008, [0013]). A POSITA would not recognize that Graham's solution would apply equally nor would modifying Nozaki be a simple design choice or modification.

245. Accordingly, it is my opinion that a POSITA would not be motivated to combine Nozaki with Graham to teach limitation [84.h.i].

5. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Graham to Disclose Limitation [84.h.ii] of Claim 84*

246. In my opinion, a POSITA would not have found it obvious to combine Nozaki with Graham to comprise a processor that "generates a plurality of thumbnails corresponding to the plurality of sections, wherein each of the plurality of thumbnails is associated with the same video information corresponding to the scene, and the display displays the plurality of thumbnails" as claimed in limitation [84.h.ii].

247. Dr. Bederson states that:

As discussed above in limitation [84h.ii], Graham discloses the use of a plurality of “thumbnail images” corresponding to “video keyframes” that are “extracted from the video information... at various points in time using a specified sampling rate” and then displayed to the user in a vertical interface. *See Supra* Section X.B.18. A POSITA would have found it obvious to modify Nozaki as recited in this limitation. *See Supra* Section X.B.18.

Ex. 1005, ¶168.

248. I understand that to mean that Dr. Bederson incorporated his opinions regarding limitation [84.h.i] for the Nozaki-Graham combination into his opinions for limitation [84.h.ii] for the Nozaki-Graham combination. I do the same—I incorporate all of my opinions in limitation [84.h.i] herein for element [84.h.ii]. In sum, my opinions that a POSITA would not be motivated to combine Nozaki with Graham to teach element [84.h.i] are equally applicable to limitation [84.h.ii].

249. Accordingly, it is my opinion that a POSITA would not be motivated to combine Nozaki with Graham to teach limitation [84.h.ii].

C. Ground 3: Nozaki in view of Haitani in further view of Kim Does Not Render Claim 84 Obvious

250. For Ground 3, neither the Petitioner nor Dr. Bederson demonstrate that Nozaki alone anticipates challenged claim 84. In an attempt to fill in the gaps of the deficiencies of Nozaki, Petitioner and Dr. Bederson have failed to show that it would

have been obvious to combine Nozaki with Haitani and/or Kim. Even if combining Nozaki with Haitani and Kim was obvious, Petitioner and Dr. Bederson have failed to show that the combination of Nozaki, Haitani, and Kim disclose each element of challenged claim 84.

I. A POSITA Would Not Have Found It Obvious To Combine Nozaki, Haitani, and Kim for Claim 84

251. Ground 3 initially fails because Dr. Bederson has stated only vague, conclusory, and unsupported reasons to combine Nozaki, Haitani, and Kim to render obvious challenged claim 84. *See* Ex. 1005, Section XI(A).

252. Dr. Bederson claims that “Kim, Nozaki and Haitani are compatible with and complementary to each other, and in my opinion a POSITA would have been motivated to combine them for this additional reason.” *See* Ex. 1005, ¶171. I disagree.

253. Dr. Bederson focuses on Haitani’s search filters but, as I explained in Section IX(A), Haitani’s filters are not modes and do not teach or disclose the first, second, or third reproducing modes of challenged claims 11-12, 16-17, and 19-20. Thus, a POSITA would not be motivated to combine Haitani with Nozaki.

254. Regarding Kim, Dr. Bederson opines not that a POSITA would have allegedly found it obvious to combine Kim with the Nozaki-Haitani combination but rather just with Nozaki, stating “A POSITA would have also found it obvious to modify the Nozaki device to incorporate the disclosures in Kim, which are directed

to searching for and reproducing specific segments within individual video files.” See Ex. 1005, ¶171. But Dr. Bederson provides no support for this statement other than his say so. Dr. Bederson presumes that Kim’s alleged method of segmenting videos could be compatible with Nozaki alone (not the Nozaki-Haitani combination that Kim is being added to) but, again, there is no support for such a statement. See *id.*

255. It is my opinion that the design requirements for Nozaki, Haitani, and Kim are substantially different. In addition, a POSITA would not be motivated to combine the teachings of Nozaki, Haitani, and Kim because they are directed to solving different problems and use different structures to solve these problems. Dr. Bederson has not considered the three references as a whole and has not accounted for these differences. Instead, Dr. Bederson selected portions of each reference and used hindsight to assemble a new system without accounting for the different objectives and goals of the systems in Nozaki, Haitani, and Kim.

256. Dr. Bederson also does not explain how a POSITA would implement the video-segmenting from Kim in portable device like Nozaki, let alone the combination of Nozaki-Haitani that Kim is being added to. Instead, Dr. Bederson conjures a purported need, describes some benefits in generalities (“improve the efficiency”), and claims Kim’s video-segmenting methods “could have easily been implemented in the Nozaki device.” But describing potential improvements that are

accomplished by the claims of the '848 Patent is the definition of hindsight. Neither Petitioner nor its expert attempts to quantify such “easy” implementation techniques. Implementing an entirely different function on a processor cannot necessarily be expected to be easy.

257. For all of the foregoing reasons, it is my opinion that a POSITA would not combine Nozaki, Haitani, and Kim.

2. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Haitani to Disclose Limitation [84.c.vii] of Claim 84*

258. For claim limitations [84pre]-[84h], for the Nozaki-Haitani-Kim combination, Dr. Bederson merely cites back to his opinions for the Nozaki-Haitani-Graham combinations. *See* Ex. 1005, ¶173 (“*See Supra* Sections X.B.1 – X.B.17.”).

259. I understand that to mean that Dr. Bederson is repeating and/or incorporating his same opinions for limitation [84.c.vii] for the Nozaki-Haitani-Graham combination into limitation [84.c.vii] for the Nozaki-Haitani-Kim combination. I do the same—I incorporate all of my opinions for limitation [84.c.vii] for the Nozaki-Haitani-Graham combination into limitation [84.c.vii] for the Nozaki-Haitani-Kim combination.

260. Namely, it is my opinion that a POSITA would not be motivated to combine Nozaki with Haitani to teach limitation [84.c.vii].

3. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Haitani to Disclose Limitation [84.d] of Claim 84.*

261. For claim limitations [84pre]-[84h], for the Nozaki-Haitani-Kim combination, Dr. Bederson merely cites back to his opinions for the Nozaki-Haitani-Graham combinations. *See* Ex. 1005, ¶173 (“*See Supra* Sections X.B.1 – X.B.17.”).

262. I understand that to mean that Dr. Bederson is repeating and/or incorporating his same opinions for limitation [84.d] for the Nozaki-Haitani-Graham combination into limitation [84.d] for the Nozaki-Haitani-Kim combination. I do the same—I incorporate all of my opinions for limitation [84.d] for the Nozaki-Haitani-Graham combination into limitation [84.d] for the Nozaki-Haitani-Kim combination.

263. Namely, it is my opinion that a POSITA would not be motivated to combine Nozaki with Haitani to teach limitation [84.d].

4. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Kim to Disclose Limitation [84.h.i] of Claim 84*

264. In my opinion, a POSITA would not have found it obvious to combine Nozaki with Kim to comprise a processor that “automatically sets a plurality of sections corresponding to the video information of the scene” as claimed in limitation [84.h.i].

265. Dr. Bederson concedes that Nozaki does not disclose this limitation and uses Kim to attempt to fill in the gaps. *See* Ex. 1005, ¶¶174-176.

266. But Dr. Bederson errs in attempting to combine Kim to only Nozaki, not the Nozaki-Haitani combination (or Nozaki alone within that combination) that Dr. Bederson relies on to disclose limitations [84.pre]-[84.h] and [84.i]. *Compare id. with id.* at ¶¶173, 179. In other words, Dr. Bederson uses two different two-reference combinations (Nozaki-Haitani and Nozaki-Kim) to purportedly disclose each of the limitations of claim 84 but does not provide any reasoning or motivation that a POSITA would look to combine all three references to disclose claim 84 in full. Dr. Bederson’s piecemeal analysis should be rejected for this reason alone.

267. Moreover, Dr. Bederson provides nothing but improper hindsight to combine Kim with only Nozaki (not the Nozaki-Haitani combination). *See id.* at ¶¶174-176.

268. Although Kim discloses a method of “video partitioning,” Kim is solving a wholly different problem with different hardware than Nozaki. *See Ex. 1009, Kim*, at 6 (“The technical problem to be solved by the present invention is to provide an apparatus and method for high-speed partition of a video according to topic based on detected main characters.”). In contrast, Nozaki defines the problem that it attempts to solve as follows:

Problem to be Solved by the Invention

[0006] The present invention is intended to solve at least one problem of the conventional technique described above. One proposition of the

present invention is to provide an electronic camera that can easily perform registration shooting when generating face recognizing data.

Another proposition of the present invention is to provide an image processing device that can read image data obtained by shooting a person in advance and easily generate facial recognition data of a target person.

[0007] Another proposition of the present invention is to provide an electronic camera that allows a user to easily and quickly recognize the outline of face recognizing data and the correspondence between face recognizing data and registered persons.

A further proposition of the present invention is that even in situations where a plurality targets to be recognized are shot at once, it is to provide an electronic camera that performs control that appropriately reflects the user's intentions based on the results of facial recognition.

[0008] Another proposition of the present invention is to provide an electronic camera that can appropriately adjust the amount of computation for face recognition processing depending on the situation.

See Ex. 1006, [0006]-[0008].

269. Dr. Bederson's reason for combining Kim with Nozaki alone is entirely conclusory. *See* Ex. 1005, ¶175. Dr. Bederson argues: "A POSITA would have found it obvious that the role of the 'face detecting unit' disclosed in Kim could be

filled by the face-recognition technology in Nozaki. Moreover, a POSITA would have found it obvious that Kim's 'multimedia content indexing technique' would be compatible with the list of face-recognition data in the 'lower part' of Figure 5 above, because the listing of face recognizing data could be used to identify "key frames" in a video file and generate 'chapter' or 'segment' markers for said file as disclosed in Kim." *See id.* I disagree.

270. Dr. Bederson points to nothing in Kim that would suggest its multimedia content indexing technique is compatible with Nozaki. Kim discloses a wholly different interface than Figure 5 of Nozaki, which provides information associated with the recording details (*e.g.*, frame rate, focus, shooting mode, etc.).

271. Dr. Bederson further argues that "A POSITA would have been motivated to modify the Nozaki device to include the automatic video segmenting functionality of Kim to improve the efficiency with which a user could search for and locate specific people in large (lengthy) video files. Kim recognizes that its segmenting function results in increased convenience of the user and 'allow[s] users to easily browse or search a desired part' of a video file. EX1009, 7. A POSITA would have appreciated that these benefits could apply to the Nozaki device." *See* Ex. 1005, ¶176. I disagree.

272. Dr. Bederson's generic references to alleged "increased convenience" and that the combination could have "benefits" is pure hindsight that is supported by nothing but his say so.

273. Accordingly, it is my opinion that a POSITA would not be motivated to combine Nozaki with Kim to teach limitation [84.h.i].

5. *A POSITA Would Not Have Found It Obvious To Combine Nozaki with Kim to Disclose Limitation [84.h.ii] of Claim 84*

274. In my opinion, a POSITA would not have found it obvious to combine Nozaki with Kim to comprise a processor that "generates a plurality of thumbnails corresponding to the plurality of sections, wherein each of the plurality of thumbnails is associated with the same video information corresponding to the scene, and the display displays the plurality of thumbnails" as claimed in limitation [84.h.ii].

275. Dr. Bederson states that: "Similar to limitation [84h.i] above, it is my opinion that a POSITA would have found it obvious to combine Kim and Nozaki to obtain this limitation. Nozaki discloses displaying thumbnail images of a person's face in its listing of face recognizing data in the lower part of Figure 5, wherein the thumbnail images show index images of a person's face corresponding to each instance in the image/video files in which each piece of face recognition data was captured." Ex. 1005, ¶178.

276. As such, I incorporate all of my opinions in limitation [84.h.i] herein for element [84.h.ii]. In sum, my opinions that a POSITA would not be motivated to combine Nozaki with Kim to teach element [84.h.i] are equally applicable to limitation [84.h.ii].

277. Dr. Bederson further argues that “A POSITA would have found it obvious to modify Nozaki so that it could list the key frame ‘chapters’ of Kim using thumbnails of the key frame as disclosed in Kim, to aid users in navigating to specific portions of a video file.” *See* Ex. 1005, ¶178. Dr. Bederson’s opinion regarding modifying Nozaki to aid users is pure hindsight. Dr. Bederson does not provide any reason or motivation that a POSITA would combine two different systems solving two different problems together.

278. Accordingly, it is my opinion that a POSITA would not be motivated to combine Nozaki with Kim to teach limitation [84.h.ii].

X. RESERVATION OF RIGHTS

279. In addition to the opinions and evidence expressed herein, I reserve the right to rebut any arguments made or evidence presented in response to this report. I also reserve the right to supplement this report based on further investigation or analysis.

APPENDIX A

Ravin Balakrishnan

Curriculum Vitae

Contact information

Mailing Address: Department of Computer Science
University of Toronto.
40 St. George Street, Room 4283
Toronto, Ontario
Canada M5S 2E4

voice: (416) 946-3448
email: ravin@dgp.toronto.edu
web: www.dgp.toronto.edu/~ravin

Education

Ph.D. Computer Science, University of Toronto, Canada. Feb 2001.
Thesis: "Issues in Bimanual Interaction for Computer Graphics."
Advisor: Prof. Bill Buxton
Advisory Committee: Prof. Mark Chignell, Prof. Eugene Fiume, Prof. Scott MacKenzie

M.Sc. Computer Science, University of Toronto, Canada. Jan 1997.
Thesis: "The Evolution and Evaluation of a 3D Input Device."
Advisor: Prof. Bill Buxton

B.Sc. (1st Class Honours), Computer Science, University of New Brunswick, Canada. May 1993.

Employment

Professor (tenured), Department of Computer Science, University of Toronto, 2011 – present.
Canada Research Chair (CRC-Tier II) in Human-Centred Interfaces, Department of Computer Science, University of Toronto, March 2006 – 2016.

Chair, Department of Computer Science, University of Toronto, 2015 – 2019.

Associate Professor (tenured), Department of Computer Science, University of Toronto, 2006- 2011.
Canada Research Chair (CRC-Tier II) in Human-Centred Interfaces, Department of Computer Science, University of Toronto, March 2006 – 2016.

Associate Chair, Research and Industrial Relations, Department of Computer Science, University of Toronto. July 1, 2008 – June 30, 2010.

Assistant Professor (tenure-track), Department of Computer Science, University of Toronto, 2001 –2006. Appointed as Full Member of the Graduate Faculty in 2001.

Researcher, User Interface Research Group, Alias|wavefront (now Autodesk), Aug 1996 – July 2001.
Conducted basic and applied research on interfaces for interactive 3D graphics, alternate multi degree-of-freedom input devices, two-handed input, haptic feedback interfaces, tablet based input, and large scale displays. Some of the ideas and interaction techniques developed in this research have been incorporated into Alias|wavefront's market leading software products for 3D design, modeling, and animation.

Instructor, Dept. of Computer Science, University of Toronto, May 1995 – Aug 2000, on a per course basis.
Lectured and took complete responsibility, including managing several teaching assistants, for various undergraduate courses (listed in section entitled "Teaching" below).

Teaching Assistant, Dept. of Computer Science, University of Toronto. Sep 1993 - Dec 1996.
Conducted tutorials and marked assignments, tests, and exams for various courses (listed in section entitled "Teaching" below).

Research Assistant, Human Computer Interaction Laboratory, University of New Brunswick, May - Sept 1993.
Worked with Prof. Colin Ware on empirical research into the effects of lag in fishtank virtual reality environments. Also helped design, build, and evaluate a haptic feedback input/output device.

Programmer Analyst, Indigo Software Ltd, Ottawa, Canada. Sep - Dec 1990, May - Aug 1991, Jan - May 1992.

Visiting and consulting researcher activities

Visiting professor, INRIA, Lille, France. Aug 2024 – Aug 2025.

Visiting researcher, HPLabs Bangalore, India. Feb 2009.

Visiting researcher, Microsoft Research - Redmond, Beijing, Bangalore and Cambridge labs. July 2007 – June 2008.

Visiting professor, Laboratoire de Recherche en Informatique (LRI), Université Paris-Sud. France. June-July, 2006

Visiting researcher, Mitsubishi Electric Research Lab (MERL), Cambridge, MA, USA. Feb 2005 – Mar 2007.

Expert witness and litigation consulting

(Note: confidential retentions or retentions where no work has been to date are not listed here)

Number of depositions: ~46

Number of times testified at trials and hearings: ~22

Expert witness for Twitch Interactive Inc through Perkins Coie LLP. Plaintiff: RazDog Holdings LLC. Case No. 3:24-CV-3638, N.D. Cal. 2024 – ongoing.

Expert witness for Figma through Allen & Gledhill LLP Singapore. Defendant: Motiff. 2024 – ongoing.

Expert witness for Apple through Haynes and Boone LLP in an IPR. 2024 – ongoing

Expert witness for Apple through GoldmanIsmail LLP. Plaintiff: S.M.R. Innovations and Y.M.R. Tech. 2024 – ongoing

Expert witness for Maxell Ltd. through Mayer Brown LLP. Defendant: LG. Maxell Ltd v. LG Electronics. Case No: 6:23-cv-00479-ADA, Western District of Texas. 2024 – ongoing.

Expert witness for Keyless Licensing through KramerAlberti. Defendant: Samsung. Keyless Licensing LLC v. Samsung Electronics America Inc. et al. Case No. 2:24-cv-00464-JRG. 2024 – ongoing.

Expert witness for ClearCorrect through Wilmer Hale. Plaintiff: Align Technology. Align Technology Inc. v. ClearCorrect Operating LLC et al., WDTX-6:24-CV-00187-ADA-DTG. 2024 – ongoing.

Expert witness for Microsoft through Sidley Austin LLP. Plaintiff: Haptix Solutions LLC. Case No. 8:24-cv-00428-JWH-JDE (C.D. California). 2024. Did some preliminary work. Case Settled.

Expert witness for Apple through Morrison Foerster LLP. Plaintiff: NL Giken Inc. Case No. 1:24-cv-00013-MN om the US District Court for the District of Delaware. 2024. Did some preliminary work. Case settled.

Expert witness for Maxell Ltd. through Mayer Brown LLP. Defendant: Samsung. Maxell v. Samsung Case No. 5:23-cv-00092-RWS, in the Eastern District of Texas, Texarkana Division. Also in IPR proceedings. 2024 – ongoing. Two reports. One deposition.

Expert witness for Lenovo Inc. through DLA Piper LLP. Defendant: ASUSTeK Computer, Inc. Case No. 5:23-cv-05892, filed in the Northern District of California, and ITC 337-TA-3708. 2024. Two reports. One deposition.

Expert witness for Apple, Inc. through Desmarais LLP. Defendant: Masimo Corporation. C.A. Nos. 22-1377 and 22-1378 in the US District Court for the District of Delaware. 2023 – ongoing. One report.

Expert witness for Niantic, Inc., through Cooley LLP. Plaintiff: NantWorks. Case No. 20-cv-06262-LB in the US District Court for the Northern District of California. 2022 – 2024. One report. One deposition. Case terminated on summary judgement in Niantic's favor.

Expert witness for Broadband iTV Inc. through Kramer Day. Defendant: Comcast, Charter, Altice. ITC Investigation No 337-1315. 2022-2023. Did some preliminary infringement analysis. Case terminated.

Expert witness for MyPort Inc. initially through One LLP then Skiermont Derby LLP. Defendant: Samsung. Case No. 2:22-cv-00114 in the US District Court for the Eastern District of Texas Marshall Division. 2022 – 2024. One report, one deposition. Case settled in 2024.

Expert witness for Consumeron LLC through Kramer Levin. Defendant: Maplebear, Inc., d/b/a/ Instacart. Case no: 1:21-cv-01147-VAC-MPT (Del). 2022 – 2023. One report, one deposition.

Expert witness for Fujifilm through Baker Botts. Defendant: Butterfly Network. Case 1:22-cv-00309-UNA (Del). 2022 – 2023. Did some preliminary work, case settled.

Expert witness for Blue Yonder Group Inc. through Cravath and then through McKool Smith. Defendant: Kinaxis. US District Court for the Northern District of Texas. Civil Action No. 3:20-cv-3636-K. 2021 – 2024. Three reports. One deposition. Case settled.

Expert witness for G Holdings through Hall Booth Smith. Defendant: Samsung. US District Court for the Eastern District of Texas Marshall Division. Civil Action No. 2:20-cv-342. 2021. One report. Case settled.

Expert witness for MLB Advanced Media through Goldman Ismail LLP. Plaintiff: Sportvision, Inc. Case No. 18-cv-03025, in the United States District Court for the Southern District of New York. 2021 – ongoing. One report.

Expert witness for Spacetime3D through Susman Godfrey. Defendant: LG Electronics. Case No. 2:22-cv-00049 (E.D. Tex.). 2022 – 2023. Did some preliminary work. Case settled.

Expert witness for Polaris PowerLED Technologies Ltd., through Kramer Day. Defendants: Nintendo. Case No. 2:22-cv-00386: 2022 -- 2023. One report.

Expert witness for Dropbox and Box through Cooley LLP in an IPR. Two reports, two depositions. 2022-2024.

Expert witness for Roku through Dickinson-Wright in an IPR Case No. IPR2022-00818. 2022. Two reports. One deposition.

Expert witness for Roku through Dickinson-Wright. Defendant: UEI. ITC Investigation No. 337-TA-1264. 2021 – 2022. Several reports. One deposition. Testified at trial.

Expert witness for Roku through Dickinson-Wright. Plaintiff: UEI. ITC Investigation No. 337-TA-1200. 2020 – 2021. Several reports. One deposition. Testified at trial.

Expert witness for Dell through Alston Bird. Plaintiff: Neodron. Case No. 1-cv-003182020. 2020. One report. Case settled.

Expert witness for Content Square SAS v. Medallia Inc. through Cooley then Troutman Pepper. IPR IPR2022-00152. 2021. One report.

Expert witness for Apple through Morrison Foerster. Plaintiff: MemoryWeb LLC. Case No. 6:21-cv-521-ADA. 2021-2022. Did some preliminary work. Case settled.

Expert witness for Spacetime3D through Susman Godfrey. Defendant: Samsung. Case 2:19-cv-00372-JRG in the U.S. District Court for the Eastern District of Texas. 2020 – 2021. Several reports. One deposition. Case settled.

Expert witness for Supercell Oy through Fenwick and West. Defendant: Gree. IPR Proceeding. 2020. Several reports.

Expert consultant for Abbott Labs UK through Taylor Wessing LLP. 2020-2021.

Expert witness for Kannuu through Progress LLP in an IPR proceedings (IPR2020-00736, -00737, -00738, -00739, -00740). Plaintiff: Samsung. 2020 – 2021. Several reports. One deposition.

Expert witness for Facebook through Cooley LLP. Plaintiff: Mirror Worlds Technologies. Case No. 1:17-cv-03473-JGK in the U.S. District Court in the Southern District of New York. 2020 – 2021. One report. One deposition.

Expert witness for Facebook through Cooley LLP. Plaintiff: Blackberry. Case No. 18-cv-1844 (C.D. Cal.). Several reports. One deposition. Case stayed in 2020 pending IPRs.

Expert witness for Bumble through Cooley LLP. Plaintiff: KinectUs LLC. Case No: 6-20-cv-00942-ADA, Western District of Texas. 2021. One report. Case settled.

Expert witness for Bumble through Cooley LLP. Plaintiff: Match. Case No: 6:18-cv-00080-ADA, Western District of Texas. 2020. One report. One deposition. Case settled.

Expert witness for Polaris PowerLED Technologies Ltd., through Feinberg Day. Defendants: Vizio. In the US District Court for the Central District of California, Civil Action No: 8-18-cv-01571-JVS-DFM. 2019 – 2020. Several reports.

Expert witness for NexStep Inc. through Kramer Levin LLP. Defendant: Comcast. Case C.A. No. 19-1031 (RGA)(SRF) in the U.S. District Courts for the State of Delaware. Judge: Hon. Richard Andrews. 2019 – 2021. One report. One deposition. Testified at trial.

Expert witness for iTools Media Inc., through Gilberts LLP. Plaintiffs: Caps Group Inc., and CASLCure Inc. Court File No T-1543-17. 2019. One report. Case settled.

Expert witness for Polaris PowerLED Technologies Ltd., through Dentons and Feinberg Day. Defendants: Samsung. No. 2-17-cv-00715-JRG, in the U.S. District Court for the Eastern District of Texas. 2018 – 2019. Several reports. One deposition. Case settled.

Expert witness for Immersion Corp, through Morrison and Foerster. Defendants: Motorola Mobility and Samsung. Case No. 1:17-cv-01081-RGA District of Delaware, Civil Action No 2:17-cv-572-JRG, Eastern District of Texas. 2017 – 2019. Several reports. Two depositions. Cases settled in 2019.

Expert witness for Immersion Corp. through McKool Smith. IPR2018-00588. 2018. One report.

Expert witness for 3Shape Inc. through Buchanan Ingersoll & Rooney. Plaintiff: Align Technology, Inc. IPR proceedings IPR2018-00197, IPR2018-00198. One report. One deposition. 2018 – 2019.

Expert witness for Rovi Corp, through Gilberts LLP then Lenczner Slaght. Plaintiffs, Videotron, Bell, Telus. 2017 – 2020. Several reports. Testified at trial. Federal Court of Canada.

Expert witness for Phillips, through Fitzpatrick, Cella, Harper and Scinto. Plaintiff: HTC corp. IPR proceedings IPR2017-00857. One report. 2017 – 2018.

Expert witness for Rovi Corp, through Ropes and Gray. Plaintiff: Comcast Corp. IPR proceedings for several patents. 2017 – 2018. Several reports, two depositions.

Expert witness for Rovi Guides Inc. through McKool Smith. Plaintiff: Comcast Corp. in Rovi Guides Inc., et al. v. Comcast Corp., et al., No. 2:16-cv-321 (EDTX); Rovi Guides Inc. v. Comcast Corp., et al., No. 2:16-cv-322 (EDTX); Certain Digital Video Receivers and Hardware and Software Components Thereof, Inv. No. 337-TA-1001,

TA-3135 (ITC); Comcast Corp., et al. v. Rovi Corp., et al., No. 1:16-cv-03852 (SDNY). 2016 – 2020. Several reports. Three depositions. Testified at two ITC trials.

Expert witness for Oculus and Palmer Luckey through Cooley, LLP, at the US District Court for the Northern District of California. Plaintiff: Total Recall Technologies. Case No. 3:2015cv02281. 2016 – 2021. Judge: Hon. William Alsup. One report. One deposition. Attended trial and prepared to testify, but ultimately was not called to testify.

Expert witness for Nuance Communications through Weil Gotshal and Manges LLP, in an IPR proceeding at the US Patent Office. 2016. Draft report prepared. Case terminated.

Expert witness for Oculus, Facebook and Palmer Luckey through Cooley, LLP. Plaintiff: ZeniMax Media Inc. and ID Software LLC. Case No. 3:14-cv-01849-P (N.D. Texas). 2015-2016. Several reports. One deposition. Testified at trial.

Expert consultant for ZTE through Upshaw PLLC. 2015. Did some preliminary prior art research.

Expert witness for Mojo Media Inc. through Morrison Foerster LLP, in a patent interference action. Interference No. 106,005, Mojo Media, Inc. v. Snapchat, Inc. 2014 – 2015. Prepared several reports. Case terminated in 2015.

Expert witness for Queens University and PARTEQ Research and Development Innovations (plaintiff) through Susman Godfrey LLP, and Sterne, Kessler, Goldstein & Fox in a patent infringement action at the US District Court for the Eastern District of Texas and an IPR proceedings at the US Patent office. Case: 2:14-cv-53. Defendant: Samsung. 2014-2016. Prepared several reports. Two depositions.

Expert witness for Greenwood Publishing Group, Inc. d/b/a Heinemann (defendant) through Wilmer Hale in a patent infringement action at the US District Court for the Southern District of New York. Case: 1:13-cv-02687-LTS-RLE. Plaintiff: Amplify Education Inc. 2014. Prepared one declaration on claim construction. Case settled in 2014.

Expert witness for Microsoft (defendant) through Sidley Austin LLP, in a patent infringement action at the US District Court for the District of Maine. Case: 2:12-cv-333-DBH. Plaintiff: SurfCast Inc. 2013 – 2014. Several reports. One deposition.

Expert witness for VMware (defendant) through Morrison Foerster, LLP, in a patent infringement action at the US District Court for the District of Delaware. Case: 13-cv-116. Plaintiff: UbiComm LLC. 2013. Several reports.

Expert witness for Hockeyline Inc. (plaintiff) through Freitas Tseng & Kaufmann LLP, in a patent infringement action at the US District Court for the Southern District of New York. Case: 1:13-cv-01446-CM. Defendant: STATS LLC. 2013 – 2015. One report. Case terminated in 2015.

Expert witness for Pixcir Microelectronics (defendant) through Nixon Peabody LLP, in a patent infringement action at the US District Court for the District of Nevada. Case: 2:10-cv-00014-GMN-PAL. Plaintiff: Elan Microelectronics. 2013. One report. Case settled in 2013.

Expert witness for Nuance (complainant) through Weil, Gotshal & Manges, LLP, in a patent infringement action at the ITC. Investigation No. 337-TA-785. Respondent: Cootek. Several reports. One deposition. Case settled in 2013.

Expert witness for Immersion (complainant) through Morrison Foerster, LLP, in a patent infringement action at the ITC, Investigation No: 337-TA-834 and in the District Court for the District of Delaware. Respondent: HTC. 2012-2015. Several reports. Two depositions. ITC case terminated in 2012, District court case settled in 2015.

Expert witness for Apple (plaintiff) through Freehills in a patent infringement action in the Federal Courts of Australia. Defendant: Samsung. 2012-2013. Prepared several reports. Testified at trial.

Expert witness for Apple (plaintiff) through Freshfields Bruckhaus Deringer in a patent infringement action in the United Kingdom. Defendant: HTC. 2012. Several reports. Case settled in Nov 2012.

Expert witness for Apple (plaintiff) through Freshfields Bruckhaus Deringer in a patent infringement action in the Netherlands. Defendant: Samsung. Prepared one declaration and attended injunction hearing.

Expert witness for Apple (plaintiff) through Gibson Dunn, LLP, in a patent infringement action at the US District Court for the Northern District of California. Defendant: Samsung. Case No. 12-cv-00630-LHK. 2012. Judge: Hon. Lucy Koh. One report. One deposition.

Expert witness for Apple (complainant) through Feinberg Day, LLP, in a patent infringement action at the ITC. Respondent: HTC. Investigation No. 337-TA- 797. 2011-2012. ALJ: Hon. E. James Gildea. Several expert reports. One deposition. Testified at trial.

Expert witness for Apple (defendant) through O'Melveny & Myers, LLP, in a patent infringement action at the US District Court for the District of Delaware. Plaintiff: MobileMedia Ideas LLC. Case No: 10-258-SLR. 2011-2016. Judge: Hon. Sue Robinson. Several reports. Two depositions. Testified at two trials.

Expert witness for Apple (respondent) through Wilmer Hale, LLP, in a patent infringement action at the ITC. Complainant: Samsung. Investigation No. 337-TA- 794. 2011-2012. ALJ: Hon. E. James Gildea. Several reports. One deposition. Testified at trial.

Expert consultant for Apple through Wilmer Hale LLP. Plaintiff: Nokia. Case No 09-791-GMS in the US District Court for the District of Delaware. 2011. Did some preliminary work.

Expert witness for Apple (plaintiff) through Morrison & Foerster, LLP, in a patent infringement action at the US District Court for the Northern District of California. Defendant: Samsung. Case No. 11-cv-01846 LHK. 2011-2013. Judge: Hon. Lucy Koh. Several reports. Multiple depositions. Testified at technology tutorial and three trials.

Expert witness for Apple (complainant) through Morrison & Foerster, LLP, in a patent infringement action at the ITC. Respondent: Samsung. Investigation No. 337-TA- 796. 2011-2012. ALJ: Hon. Thomas Pender. Several reports. One deposition. Testified at technology tutorial and at trial.

Expert witness for Apple (complainant) through Weil, Gotshal & Manges, LLP, in a patent infringement action at the ITC. Respondent: Motorola. Investigation No. 337-TA- 750. 2011. ALJ: Hon. Theodore Essex. Several reports. One deposition. Testified at trial.

Expert witness for Apple (defendant) through Weil, Gotshal & Manges, LLP, in a patent infringement action in the US District Court for the Northern District of California. Plaintiff: Elan Microelectronics. Case No. 5:09-cv-01531-RS (N.D. Cal) 2010-2012. Judge: Hon. Richard Seeborg. Several declarations. Case settled in 2012.

Expert witness for Apple (respondent) through Weil, Gotshal & Manges, LLP, in a patent infringement action at the ITC. Complainant: Elan Microelectronics. Investigation No. 337-TA-714. 2010-2011. CALJ: Hon. Paul Luckern. Several reports. Two depositions. Testified at Markman hearing and at trial.

Expert witness for Nintendo (respondent) through Covington and Burling, LLP, in a patent infringement action at the ITC. Complainant: Hillcrest Laboratories. Investigation No. 337-TA-658. 2008-2009. CALJ: Hon. Paul Luckern. Several reports. Two depositions. Testified at trial.

Entrepreneurial Activities

Co-founder, Conceptualiz www.conceptualiz.com. Developing surgical planning technology.

Co-founder, FindSpace (formerly Arcestra, and Sketch2 Corp). Acquired by Cougar Group in 2021. Developed software for designing 3D building interior layouts. The concept grew out of research conducted in my lab with my colleague Prof. Karan Singh and graduate students Steven Tsang and Abhishek Ranjan.

Co-founder, Bump Technologies Inc. www.bumptop.com. Acquired by Google in May, 2010. Developed a physically realistic desktop user interface system, which grew out of research conducted in my lab with graduate student Anand Agarawala.

Awards, fellowships, scholarships

Canadian Human Computer Communications Society Achievement Award, 2020

Dean's Excellence Award, Faculty of Arts and Science, University of Toronto. 2016.

10-year impact award at the ACM Interactive Tabletops and Surfaces conference 2016 for paper published in 2006.

Two best paper honorable mention awards at the ACM CHI 2016 Conference on Human Factors in Computing Systems.

Best paper honorable mention award at the ACM CHI 2013 Conference on Human Factors in Computing Systems.

Elected to the ACM CHI Academy in 2011.

Dean's Excellence Award, Faculty of Arts and Science, University of Toronto. 2010.

Best paper award at the ACM CHI 2010 Conference on Human Factors in Computing Systems.

Best paper honorable mention award at the ACM CSCW 2010 Conference on Computer Supported Cooperative Work.

Dean's Excellence Award, Faculty of Arts and Science, University of Toronto. 2009.

Best paper honorable mention award at the ACM CHI 2009 Conference on Human Factors in Computing Systems.

Dean's Excellence Award, Faculty of Arts and Science, University of Toronto. 2008.

Best paper honorable mention award at the ACM CHI 2008 Conference on Human Factors in Computing Systems.

Alfred P. Sloan Research Fellowship. 2007-2009. US\$45,000.

Dean's Excellence Award, Faculty of Arts and Science, University of Toronto. 2007.

Canada Research Chair (CRC-Tier II) in Human-Centred Interfaces, University of Toronto, March 2006 – 2016.

Dean's Excellence Award, Faculty of Arts and Science, University of Toronto. 2006.

Best paper honorable mention award at the ACM CSCW 2006 Conference on Computer Supported Cooperative Work.

Best student paper award at the ACM UIST 2006 Symposium on User Interface Software and Technology.

Best paper award at the Graphics Interface 2005 Conference.

Dean's Excellence Award, Faculty of Arts and Science, University of Toronto. 2005.

Best paper award at the ACM CHI 2005 Conference on Human Factors in Computing Systems.

Best paper award at the ACM UIST 2004 Symposium on User Interface Software and Technology.

Dean's Excellence Award, Faculty of Arts and Science, University of Toronto. 2004.

Ontario Premier's Research Excellence Award (PREA). 2003. \$100,000.

IBM Toronto Centre for Advanced Studies Faculty Fellow (2003-present).

Bell University Laboratories Associate Chair in Human Computer Interaction, U. of Toronto, Jan 2002 – 2006.

Ph.D. fellowship from Alias|wavefront, \$30,000 per annum plus travel/research expenses, Sep 1996 – July 2001.

University of Toronto, Dept. of Computer Science award for outstanding Teaching Assistant, 1994.

University of Toronto Open Fellowship, \$4500, Sep - Dec 1994 .

University of Toronto Connaught Scholarship, \$13,500 plus tuition fees, Sep 1993 - Aug 1994.

Harry Levine Award for outstanding graduating student in Computer Science, University of New Brunswick, 1993.
University of New Brunswick, Dept. of Computer Science Dean's List, 1990, 1991, 1992, 1993.

Research Grants

(Unless otherwise indicated, all figures are in Canadian dollars and I am the sole investigator/recipient of the following grants and awards)

“Subtle user interfaces.”

NSERC discovery grant DND supplement, 1 Jan 2018 – 31 Dec 2020, \$120,000.

“Subtle user interfaces.”

NSERC discovery grant, 1 April 2017 – 31 March 2023, \$204,000.

“User interfaces and visualization for variable format displays.”

NSERC discovery grant, 1 April 2012 – 31 March 2017, \$52,000 per year.

Network Investigator in the “GRAND Networks Centres of Excellence”. PI: Kellogg Booth. 2010-2013.

Sony Corporation Grant, 2012. \$42,000.

HPLabs India unrestricted gift. Jan 2010. US\$15,000.

“Going beyond the surface”.

Microsoft Research unrestricted gift. 1 July 2009. US\$100,000 + hardware donation valued at approximately US\$15,000.

“3-D visualization and gestural interaction with multimodal neurological data.”

NSERC Strategic Project Grants Supplemental Competition, 1 April 2008 – 31 March 2010, \$196,000 over 2 years (\$98,000 per year).

PI: Jeremy Cooperstock. Co-investigators: Ravin Balakrishnan, Tal Arbel, Louis Collins.

“Multi channel and multi degree-of-freedom user interfaces for heterogeneous display environments.”

NSERC discovery accelerator supplement grant, 1 April 2007 – 31 March 2010, \$120,000 over 3 years (\$40,000 per year)

“Multi channel and multi degree-of-freedom user interfaces for heterogeneous display environments.”

NSERC discovery grant, 1 April 2007 – 31 March 2012, \$166,000 over 5 years (\$33,200 per year)

“Multi-Scale Environments”

INRIA "Equipes Associées" grant. 60,000 Euros over 3 years beginning Jan 2007.

PIs: Wendy Mackay and Ravin Balakrishnan

“3D Sketch Graphics Software Development Project”.

NSERC Idea to Innovation (I2I) Phase 2 grant. \$125,000 for one year, 2006.

PI: Karan Singh. Co-investigator: Ravin Balakrishnan

“Management, Access, and Visualization of Archived Meeting Transcripts”,

NSERC Collaborative Research and Development (CRD) grant. \$360,000 over 3 years beginning 1 Jan 2006.

PI: Charles Clarke. Co-investigators: Ravin Balakrishnan, Mark Chignell, Sharon Strauss.

“3D Sketch Graphics Software Development Project”.

NSERC Idea to Innovation (I2I) Phase 1 grant. \$125,000 for one year, 2005.

PI: Karan Singh. Co-investigator: Ravin Balakrishnan

“3D Sketching with a Suggestion Database”.

CITO Technical Readiness grant. \$25,000, for one year, 2005.

PI: Karan Singh. Co-investigator: Ravin Balakrishnan

“3D Sketching Software”

NSERC IPM grant. \$50,000, for one year, 2005.

PI: Karan Singh. Co-investigator: Ravin Balakrishnan

“Improved Medical Collaboration and Case Management: Capture, Structuring and Dissemination of Spoken Discussion”.

CITO research grant. \$280,000 over two years beginning 1 Sep 2004.

PI: Mark Chignell. Co-investigators: Ravin Balakrishnan, Charles Clarke, Sharon Strauss.

“Next Generation User Interfaces for Data Visualization”

NSERC strategic grant. \$263,800 over the period 1 Jan 2004 – 31 Dec 2006.

PI: Ravin Balakrishnan. Co-investigator: Karan Singh

“User Interfaces for Database Visualization”

CITO student internship program grant, \$15,000, 1 Jan – 31 Dec 2004.

“Network for Effective Collaboration Technologies through Advanced Research”

NSERC research network grant. \$5.5million over 5 years beginning Jan 2004.

PI: Ron Baecker. Co-investigators: Ravin Balakrishnan, Saul Greenberg, Carl Gutwin, Kellogg Booth, Sheelagh Carpendale, Kori Inkpen, Gerald Penn, Kostas Plataniotis, Elaine Toms, Roel Vertegaal.

“Memories of Synchronicity: Knowledge Management and Visualization of Interaction Transcripts in Innovative Collaboration Environments”

IBM-ARISE research grant. Sept 2003 – Aug 2006, \$450,000.

PI: Mark Chignell. Co-investigators: Ravin Balakrishnan, Charles Clarke.

“Mathematical Surface Representations for Conceptual Design”

Mathematics of Information Technology and Complex Systems (MITACS) grant.

Original award: May 2003 – Apr 2005, \$180,000.

Additional award: May 2005, \$180,000

PI: Karan Singh. Co-investigators: Ravin Balakrishnan, Eugene Fiume, Pierre Poulin, Michiel van de Panne, Richard Zhang.

“Tablet Interfaces”

Microsoft Research unrestricted gift. July 2003. US\$25,000 cash.

“Laboratory for human-computer interaction and computer graphics”

CFI New Opportunities Fund grant. 2003-2007. \$994,066. 40% CFI, 40% OIT, 20% from industrial partners

PI: Ravin Balakrishnan. Co-investigator: Karan Singh.

“Laboratory for human-computer interaction and computer graphics”

CFI Infrastructure Operating Fund grant. 2004-2006. \$132,000.

PI: Ravin Balakrishnan. Co-investigator: Karan Singh.

“User interfaces for 3D environments”

IBM Centre for Advanced Studies grant to support my Ph.D. student, Michael McGuffin. 1 Jan 2003 – 31 Dec 2005
\$102,000 cash + \$23,000 in-kind.

“Tilting text input for mobile devices.”

Microsoft Research unrestricted gift. 1 Jan 2003. US\$25,000 cash + hardware donation valued at approximately US\$5,000.

“User interfaces for volumetric displays.”

Connaught Fund matching grant, 1 April 2002 – 31 March 2003. \$30,000 (+\$15,000 from the department)

“Laboratory for large scale high resolution interaction, graphics and vision research.”

NSERC equipment grant, 1 April 2002 – 31 March 2003, \$96,792

PI: Ravin Balakrishnan. Co-investigators: Karan Singh, Kyros Kutulakos, Eugene Fiume

“Multi-channel and multi degree-of-freedom interaction with large displays.”

NSERC discovery grant, 1 April 2002 – 31 March 2007, \$140,000 over 5 years (\$28,000 per year)

“Techniques for multi-channel and multi degree-of-freedom interaction.”

Connaught startup grant, 1 July 2001 – 30 June 2003, \$10,000.

Bell University Laboratories startup funding, 1 July 2001 – 31 Dec 2003, \$60,000

Publications

Copies of the following papers and related videos are available online at www.dgp.toronto.edu/~ravind/publications

A note on publication venues: in my primary area of research in Human Computer Interaction (HCI), the ACM Conference on Human Factors in Computing Systems (CHI) is considered one of the best forums for dissemination of research results and covers the broad spectrum of research in HCI. The ACM Symposium on User Interface Software and Technology (UIST), the ACM Conference on Computer Supported Cooperative Work (CSCW), and the European Conference on Computer Supported Cooperative Work (ECSCW) are also of similar quality, but are focused on particular sub-areas of the field. Papers in these conferences are refereed as full papers, and have an acceptance rate of around 15-25% each year. The top journals in the HCI field are the ACM Transactions on Computer-Human Interaction, the Human Computer Interaction journal, and the International Journal of Human Computer Studies. I also do research in the fields of Information Visualization and Information and Communication Technologies for Development (ICTD) where the IEEE Visualization Conference, IEEE Information Visualization Symposium, and the IEEE/ACM International Conference on Information and Communication Technologies for Development are the top publication venues with acceptance rates of around 20-30%.

Refereed journal papers

- J1. Jian Zhao, R. William Soukoreff, Ravin Balakrishnan. (2015). Exploring and modeling unimanual object manipulation on multi-touch displays. *IJHCS: International Journal of Human-Computer Studies*, 78(0). p. 68-80.
- J2. Jian Zhao, R. William Soukoreff, Xiangshi Ren, Ravin Balakrishnan. (2014). A model of scrolling on touch-sensitive displays. *IJHCS: International Journal of Human-Computer Studies*, 72(12). p. 805-821
- J3. Jian Zhao, Christopher Collins, Fanny Chevalier, Ravin Balakrishnan. (2013). Interactive exploration of implicit and explicit relations in faceted datasets. *IEEE Transactions on Visualization and Computer Graphics (Proceedings of VAST 2013)*. p. 2080-2089.
- J4. Xiaojun Bi, Seok-Hyung Bae, Ravin Balakrishnan. (2013). WallTop: Managing overflowing windows on a large display. *Human-Computer Interaction*, 29(2). p. 153-203.
- J5. Chun Yu, Ravin Balakrishnan, Ken Hinckley, Tomer Moscovich, Yuanchun Shi. (2013). Implicit bookmarking: Improving support for revisitation in within-document reading tasks. *International Journal of Human Computer Studies*, 71(3). p. 303-320.
- J6. Jian Zhao, Fanny Chevalier, Christopher Collins, Ravin Balakrishnan. (2012). Facilitating discourse analysis with interactive visualization. *IEEE Transactions on Visualization and Computer Graphics*. 18(12). p. 2639-2648.
- J7. Jian Zhao, Fanny Chevalier, Emmanuel Pietriga, Ravin Balakrishnan. (2011). Exploratory analysis of time-series with ChronoLenses. *IEEE Transactions on Visualization and Computer Graphics*. 17(12). p. 2422-2431
- J8. Daniel Vogel, Ravin Balakrishnan. (2010). Direct pen interaction with a conventional graphical user interface. *Human-Computer Interaction*, 25(4). p. 324 -388.
- J9. Jeremy Birnholtz, Abhishek Ranjan, Ravin Balakrishnan. (2010). Providing dynamic visual information for collaborative tasks: Experiments with automatic camera control. *Human-Computer Interaction*, 25(3). p. 261-287.
- J10. Jennifer Keelan, Vera Pavri, Ravin Balakrishnan, Kumanan Wilson. (2010). An analysis of the Human Papilloma Virus vaccine debate on MySpace blogs. *Vaccine*, 28(6). p. 1535-1540
- J11. Gery Casiez, Daniel Vogel, Ravin Balakrishnan, Andy Cockburn. (2008). The impact of control-display gain on user performance in pointing tasks. *Human-Computer Interaction*, 23(3). p. 215-250.

- J12. Michael McGuffin, Ravin Balakrishnan. (2005). Fitts' law and expanding targets: Experimental studies and designs for user interfaces. *ACM Transactions on Computer-Human Interaction*, 12(4). p. 388-422.
- J13. Tovi Grossman, Ravin Balakrishnan. (2005). A probabilistic approach to modeling two-dimensional pointing. *ACM Transactions on Computer-Human Interaction*, 12(3). p. 435-459.
- J14. Anastasia Bezerianos, Ravin Balakrishnan. (2005). Canvas portals: view and space management on large displays. *IEEE Computer Graphics and Applications* 25(4). p. 34-43.
- J15. Ravin Balakrishnan. (2004). "Beating" Fitts' law: Virtual enhancements for pointing facilitation. *International Journal of Human-Computer Studies*, 61(6). p. 857-874.
- J16. George W. Fitzmaurice, Azam Khan, William Buxton, Gordon Kurtenbach, Ravin Balakrishnan. (2003). Sentient data access via a diverse society of devices. *ACM Queue*, November 2003. p. 53-62.
- J17. Ravin Balakrishnan, George W. Fitzmaurice, Gordon Kurtenbach. (2001). User interfaces for volumetric displays. *IEEE Computer*, March 2001. p. 37-45.
- J18. William Buxton, George W. Fitzmaurice, Ravin Balakrishnan, Gordon Kurtenbach. (2000). Large displays in automotive design. *IEEE Computer Graphics and Applications*, July/August 2000. p. 68-75.
- J19. George W. Fitzmaurice, Ravin Balakrishnan, Gordon Kurtenbach. (1999). Sampling, synthesis, and input devices. *Communications of the ACM*, August 1999, 42(8). p. 54-63.
- J20. Colin Ware, Ravin Balakrishnan. (1994). Reaching for objects in VR displays: Lag and frame rate. *ACM Transactions on Computer-Human Interaction*, 1(4). p. 331-356.

Refereed conference full-length papers

- C1. Jiannan Li, Maurício Sousa, Karthik Mahadevan, Bryan Wang, Paula Akemi Aoyagui, Nicole Yu, Angela Yang, Ravin Balakrishnan, Anthony Tang, Tovi Grossman. (2023). Stargazer: An Interactive Camera Robot for Capturing How-To Videos Based on Subtle Instructor Cues. *Proceedings of CHI 2023 – the ACM Conference on Human Factors in Computing Systems*.
- C2. Jiannan Li, Maurício Sousa, Chu Li, Jessie Liu, Yan Chen, Ravin Balakrishnan, Tovi Grossman. (2022). Asteroids: Exploring Swarms of Mini-Telepresence Robots for Physical Skill Demonstration. *Proceedings of CHI 2022 – the ACM Conference on Human Factors in Computing Systems*.
- C3. Jiannan Li, Jiahe Lyu, Maurício Sousa, Ravin Balakrishnan, Anthony Tang, Tovi Grossman. (2021). Route Tapestries: Navigating 360° Virtual Tour Videos Using Slit-Scan Visualizations. *Proceedings of UIST 2021 – the ACM Symposium on User Interface Software and Technology*.
- C4. Jiannan Li, Ravin Balakrishnan, Tovi Grossman. (2020). StarHopper: A Touch Interface for Remote Object-Centric Drone Navigation *Proceedings of Graphics Interface 2020*.
- C5. Laura Di Chen, Ravin Balakrishnan, Tovi Grossman (2020). Disambiguation Techniques for Freehand Object Manipulations in Virtual Reality. *Proceedings of IEEE Conference on Virtual Reality and 3D User Interfaces*.
- C6. Di Chen, Dustin Freeman, Ravin Balakrishnan. (2019). Integrating Multimedia Tools to Enrich Interactions in Live Streaming for Language Learning. *Proceedings of CHI 2019 – the ACM Conference on Human Factors in Computing Systems*.
- C7. Aakar Gupta, Jiushan Yang, Ravin Balakrishnan. (2018). Asterisk and Obelisk: Motion Codes for Passive Tagging. *Proceedings of UIST 2018 – the ACM Symposium on User Interface Software and Technology*.
- C8. Teng Han, Jiannan Li, Khalad Hasan, Keisuke Nakamura, Randy Gomez, Ravin Balakrishnan, Pourang Irani. (2018). PageFlip: Leveraging page-flipping gestures for efficient command and value selection on smartwatches. *Proceedings of CHI 2018 – the ACM Conference on Human Factors in Computing Systems*.

- C9. Aakar Gupta, Antony Irudayaraj, Ravin Balakrishnan. (2017). HapticClench: Investigating squeeze sensations using memory alloys. *Proceedings of UIST 2017 – the ACM Symposium on User Interface Software and Technology*.
- C10. Aakar Gupta, Thomas Pietrzak, Cleon Yau, Nicolas Roussel, Ravin Balakrishnan. (2017). Summon and Select: Rapid interaction with interface controls in mid-air. *Proceedings of ISS 2017 – the ACM Conference on Interactive Surfaces and Spaces*.
- C11. Rorik Henrikson, Bruno De Araujo, Fanny Chevalier, Karan Singh, Ravin Balakrishnan. (2016). Multi-device storyboards for cinematic narratives in VR. *Proceedings of UIST 2016 – the ACM Symposium on User Interface Software and Technology*.
- C12. Aakar Gupta, Antony Irudayaraj, Vimal Chandran, Goutham Palaniappan, Khai Truong, Ravin Balakrishnan. (2016). Haptic learning of freehand semaphoric gesture shortcuts. *Proceedings of UIST 2016 – the ACM Symposium on User Interface Software and Technology*.
- C13. Aakar Gupta, Muhammed Anwar, Ravin Balakrishnan. (2016). Porous interfaces for small screen multitasking using finger identification. *Proceedings of UIST 2016 – the ACM Symposium on User Interface Software and Technology*.
- C14. Dustin Freeman, Ravin Balakrishnan. (2016). Improv Remix: Mixed-reality video manipulation using whole-body interaction to extend improvised theatre. *Proceedings of DIS 2016 – The ACM Conference on Designing Interactive Systems*.
- C15. Rorik Henrikson, Bruno De Araujo, Fanny Chevalier, Karan Singh, Ravin Balakrishnan. (2016) Storeoboard: Sketching stereoscopic storyboards. *Proceedings of CHI 2016 – the ACM Conference on Human Factors in Computing Systems*. p. 4587–4598
- C16. Aakar Gupta, Ravin Balakrishnan. (2016). DualKey: Miniature screen text entry via finger manipulation. *Proceedings of CHI 2016 – the ACM Conference on Human Factors in Computing Systems*. p. 59-70 **[ACM CHI 2016 Best Paper Honorable Mention Award]**
- C17. Aakar Gupta, Thomas Pietrzak, Nicolas Roussel, Ravin Balakrishnan. (2016). Direct manipulation in tactile displays. *Proceedings of CHI 2016 – the ACM Conference on Human Factors in Computing Systems*. p. 3683–3693. **[ACM CHI 2016 Best Paper Honorable Mention Award]**
- C18. Dustin Freeman, Stephanie Santosa, Fanny Chevalier, Ravin Balakrishnan, Karan Singh. (2013). LACES: Live authoring through compositing and editing of streaming video. *Proceedings of CHI 2014 – the ACM Conference on Human Factors in Computing Systems*. p. 1207-1216.
- C19. Jian Zhao, Daniel Wigdor, Ravin Balakrishnan. (2013). TrailMap: Facilitating information seeking in a multi-scale digital map via implicit bookmarking. *Proceedings of CHI 2013 – the ACM Conference on Human Factors in Computing Systems*. p. 3009-3018.
- C20. Sajad Shirali-Shahreza, Gerald Penn, Ravin Balakrishnan, Yashar Ganjali. (2013). SeeSay and HearSay CAPTCHAs for mobile interaction. *Proceedings of CHI 2013 – the ACM Conference on Human Factors in Computing Systems*. p. 2147-2156.
- C21. Stephanie Santosa, Fanny Chevalier, Ravin Balakrishnan, Karan Singh. (2013). Direct space-time trajectory control for visual media editing. *Proceedings of CHI 2013 – the ACM Conference on Human Factors in Computing Systems*. p. 1149-1158. **[ACM CHI 2013 Best Paper Honorable Mention Award]**
- C22. Mohit Jain, Ravin Balakrishnan. (2012). User learning and performance with bezel menus. *Proceedings of CHI 2012 – the ACM Conference on Human Factors in Computing Systems*. p. 2221-2230.

- C23. Aakar Gupta, William Thies, Edward Cutrell, Ravin Balakrishnan. (2012). mClerk: Enabling mobile crowdsourcing in developing regions. *Proceedings of CHI 2012 – the ACM Conference on Human Factors in Computing Systems*. p. 1843-1852.
- C24. Navkar Samdaria, Akhil Mathur, Ravin Balakrishnan. (2012). Paying in kind for crowdsourced work in developing regions. *Proceedings of the Pervasive 2012 Conference*. p. 343-360.
- C25. Dustin Freeman, Ravin Balakrishnan. (2011). Tangible actions. *Proceedings of ITS 2011 – the ACM International Conference on Interactive Tabletops and Surfaces*. p. 87-96.
- C26. Yannick Thiel, Karan Singh, Ravin Balakrishnan. (2011). Elasticurves: Exploiting stroke dynamics and inertia for the real-time neatening of sketched 2D curves. *Proceedings of UIST 2011 – the ACM Symposium on User Interface Software and Technology*. p. 383-392.
- C27. Sajad Shirali-Shahreza, Yashar Ganjali, Ravin Balakrishnan. (2011). Verifying human users in speech-based interactions. *Proceedings of the Annual Conference of the International Speech Communication Association (INTERSPEECH)*. p. 1585-1588.
- C28. Akhil Mathur, Divya Ramachandran, Ed Cutrell, Ravin Balakrishnan. (2011). An exploratory study on the use of camera phones and pico projectors in rural India. *Proceedings of MobileHCI 2011*. p. 347-356.
- C29. Mohit Jain, Jeremy Birnholtz, Ed Cutrell, Ravin Balakrishnan. (2011). Exploring display techniques for mobile collaborative learning in developing regions. *Proceedings of MobileHCI 2011*. p. 81-90.
- C30. Jian Zhao, Fanny Chevalier, Ravin Balakrishnan. (2011). KronoMiner: Using multi-foci navigation for the visual exploration of time-series data. *Proceedings of CHI 2011 – the ACM Conference on Human Factors in Computing Systems*. p. 1737-1746.
- C31. Chun Yu, Yuanchun Shi, Ravin Balakrishnan, Xiangliang Meng, Yue Suo, Mingming Fan, Yongqiang Qin. (2010). The satellite cursor: achieving MAGIC pointing without gaze tracking using multiple cursors. *Proceedings of UIST 2010 – the ACM Symposium on User Interface Software and Technology*. p. 163-172.
- C32. James Scott, Shahram Izadi, Leila Rezai, Dominika Ruskowski, Xiaojun Bi, Ravin Balakrishnan. (2010). RearType: Text entry using keys on the back of a device. *Proceedings of MobileHCI 2010*. p. 171-179.
- C33. Abhishek Ranjan, Jeremy Birnholtz, Rorik Henrikson, Ravin Balakrishnan, Dana Lee. (2010). Automatic camera control using unobtrusive vision and audio tracking. *Proceedings of GI 2010 – the Graphics Interface Conference*. p. 47-54.
- C34. Daniel Vogel, Ravin Balakrishnan. (2010). Occlusion-aware interfaces. *Proceedings of CHI 2010 – the ACM Conference on Human Factors in Computing Systems*. p. 263-272. [ACM CHI 2010 Best Paper Award]
- C35. Patrick Dubroy, Ravin Balakrishnan. (2010). A study of tabbed browsing among Mozilla Firefox users. *Proceedings of CHI 2010 – the ACM Conference on Human Factors in Computing Systems*. p. 673-682.
- C36. Xiaojun Bi, Seok-Hyung Bae, Ravin Balakrishnan. (2010). Effects of interior bezels of tiled-monitor large displays on visual search, tunnel steering, and target selection. *Proceedings of CHI 2010 – the ACM Conference on Human Factors in Computing Systems*. p. 65-74.
- C37. Saleema Amershi, Meredith Ringel Morris, Neema Moraveji, Ravin Balakrishnan, Kentaro Toyama. (2010). Multiple mouse text entry for single-display groupware. *Proceedings of CSCW 2010 – the ACM Conference on Computer Supported Cooperative Work*. p. 169-178. [ACM CSCW 2010 Best Paper Honorable Mention Award]
- C38. Seok-Hyung Bae, Ravin Balakrishnan, Karan Singh. (2009). EverybodyLovesSketch: 3D sketching for a broader audience. *Proceedings of UIST 2009 – the ACM Symposium on User Interface Software and Technology*. p. 59-68.

- C39. Scott Saponas, Desney Tan, Dan Morris, Ravin Balakrishnan, Jim Turner, James Landay. (2009). Enabling always-available input with muscle-computer interfaces. *Proceedings of UIST 2009 – the ACM Symposium on User Interface Software and Technology*. p. 167-176.
- C40. Gursharan Singh, Leah Findlater, Kentaro Toyama, Scott Helmer, Rikin Gandhi, Ravin Balakrishnan. Numeric paper forms for NGOs. (2009). *Proceedings of ICTD 2009 – the IEEE/ACM International Conference on Information and Communication Technologies and Development*. p. 406-416.
- C41. Gerry Chu, Sambit Satpathy, Kentaro Toyama, Rikin Gandhi, Ravin Balakrishnan. (2009). Featherweight multimedia for information dissemination. *Proceedings of ICTD 2009 – the IEEE/ACM International Conference on Information and Communication Technologies and Development*. p. 337-347.
- C42. Daniel Vogel, Matthew Cudmore, Gery Casiez, Ravin Balakrishnan, Liam Keliher. (2009). Hand occlusion with tablet-sized direct pen input. *Proceedings of CHI 2009 – the ACM Conference on Human Factors in Computing Systems*. p. 557-566.
- C43. Xiaojun Bi, Ravin Balakrishnan. (2009). Comparing usage of a large high-resolution display to single or dual desktop displays for daily work. *Proceedings of CHI 2009 – the ACM Conference on Human Factors in Computing Systems*. p. 1005-1014.
- C44. Clifton Forlines, Ravin Balakrishnan. (2009). Improving visual search with image segmentation. *Proceedings of CHI 2009 – the ACM Conference on Human Factors in Computing Systems*. p. 1093-1102. [**ACM CHI 2009 Best Paper Nominee**]
- C45. Leah Findlater, Ravin Balakrishnan, Kentaro Toyama. (2009). Comparing semiliterate and illiterate users' ability to transition from audio+text to text-only interaction. *Proceedings of CHI 2009 – the ACM Conference on Human Factors in Computing Systems*. p. 1751-1760.
- C46. Ken Hinckley, Morgan Dixon, Raman Sarin, Francois Guimbretiere, Ravin Balakrishnan. (2009). Codex: A dual screen computer. *Proceedings of CHI 2009 – the ACM Conference on Human Factors in Computing Systems*. p. 1933-1942.
- C47. Neema Moraveji, Kori Inkpen, Ed Cutrell, Ravin Balakrishnan. (2009). A mischief of mice: Examining children's performance in single display groupware systems with 1 to 32 mice. *Proceedings of CHI 2009 – the ACM Conference on Human Factors in Computing Systems*. p.2157-2166.
- C48. Xiang Cao, Michael Massimi, Ravin Balakrishnan. (2008). Flashlight Jigsaw: An exploratory study of an ad-hoc multi-player game on public displays. *Proceedings of CSCW 2008 – the ACM Conference on Computer Supported Cooperative Work*. p. 77-86.
- C49. Hrvoje Benko, Andrew Wilson, Ravin Balakrishnan. (2008). Sphere: Multi-touch interactions on a spherical display. *Proceedings of UIST 2008 – the ACM Symposium on User Interface Software and Technology*. p. 77-86.
- C50. Xiaojun Bi, Tomer Moscovich, Gonzalo Ramos, Ravin Balakrishnan, Ken Hinckley. (2008). An exploration of pen rolling for pen-based interaction. *Proceedings of UIST 2008 – the ACM Symposium on User Interface Software and Technology*. p. 191-200.
- C51. Seok-Hyung Bae, Ravin Balakrishnan, Karan Singh. (2008). ILoveSketch: As-natural-as-possible sketching system for creating 3D curve models. *Proceedings of UIST 2008 – the ACM Symposium on User Interface Software and Technology*. p. 151-160.
- C52. Xiang Cao, Andrew Wilson, Ravin Balakrishnan, Ken Hinckley, Scott E. Hudson. (2008). ShapeTouch: Leveraging contact shape on interactive surfaces. *Proceedings of TABLETOP 2008 – the IEEE International Workshop on Horizontal Interactive Human Computer Systems*. p. 139-146.

- C53. Archana Prasad, Indrani Medhi, Kentaro Toyama, Ravin Balakrishnan. (2008). Exploring the feasibility of video mail for illiterate users. *Proceedings of AVI 2008 - the Conference on Advanced Visual Interfaces*. p. 103-110.
- C54. Ryan Schmidt, Karan Singh, Ravin Balakrishnan. (2008). Sketching and composing widgets for 3D manipulation. *Computer Graphics Forum*, 27(2), *Proceedings of Eurographics Conference*. p. 301-310.
- C55. Scott Saponas, Desney Tan, Dan Morris, Ravin Balakrishnan. (2008). Demonstrating the feasibility of using forearm electromyography for muscle-computer interfaces. *Proceedings of CHI 2008 – the ACM Conference on Human Factors in Computing Systems*. p. 515-524.
- C56. Xiang Cao, Jacky Jie Li, Ravin Balakrishnan. (2008). Peephole pointing: Modeling acquisition of dynamically revealed targets. *Proceedings of CHI 2008 – the ACM Conference on Human Factors in Computing Systems*. p. 1699-1708. [ACM CHI 2008 Best Paper Nominee]
- C57. Tovi Grossman, Ravin Balakrishnan. (2008). Collaborative interaction with volumetric displays. *Proceedings of CHI 2008 – the ACM Conference on Human Factors in Computing Systems*. p. 383-392.
- C58. Clifton Forlines, Ravin Balakrishnan. (2008). Evaluating tactile feedback and direct vs. indirect stylus input in pointing and crossing selection tasks. *Proceedings of CHI 2008 – the ACM Conference on Human Factors in Computing Systems*. p. 1563-1572.
- C59. Abhishek Ranjan, Jeremy Birnholtz, Ravin Balakrishnan. (2008). Improving meeting capture by applying television production principles with audio and motion detection. *Proceedings of CHI 2008 – the ACM Conference on Human Factors in Computing Systems*. p. 227-238.
- C60. Pierre Dragicevic, Gonzalo Ramos, Jacobo Bibliowicz, Derek Nowrouzezahrai, Ravin Balakrishnan, Karan Singh. (2008). Video browsing by direct manipulation. *Proceedings of CHI 2008 – the ACM Conference on Human Factors in Computing Systems*. p. 237-246.
- C61. Xiang Cao, Clifton Forlines, Ravin Balakrishnan. (2007). Multi-user interaction using handheld projectors. *Proceedings of UIST 2007 – the ACM Symposium on User Interface Software and Technology*. p. 43-52.
- C62. Shengdong Zhao, Pierre Dragicevic, Mark Chignell, Ravin Balakrishnan, Patrick Baudisch. (2007). earPod: Eyes-free menu selection using touch input and reactive audio feedback. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 1395-1404.
- C63. Clifton Forlines, Chia Shen, Daniel Wigdor, Ravin Balakrishnan. (2007). Direct-touch vs. mouse input for tabletop displays. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 647-656.
- C64. Gonzalo Ramos, Ravin Balakrishnan. (2007). Pressure marks. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 1375-1384.
- C65. Gonzalo Ramos, Andy Cockburn, Ravin Balakrishnan, Michel Beaudoin-Lafon. (2007). Pointing lenses. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 757-766.
- C66. Abhishek Ranjan, Jeremy Birnholtz, Ravin Balakrishnan. (2007). Dynamic shared visual spaces: Experimenting with automatic camera control in a remote repair task. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 1177-1186.
- C67. Daniel Wigdor, Chia Shen, Clifton Forlines, Ravin Balakrishnan. (2007). Perception of elementary graphical elements in tabletop and multi-surface environments. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 473-482.

- C68. Jeremy Birnholtz, Tovi Grossman, Clarissa Mak, Ravin Balakrishnan. (2007). An exploratory study of input configuration and group process in a negotiation task using a large display. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 91-100.
- C69. Tovi Grossman, Nicholas Kong, Ravin Balakrishnan. (2007). Modeling pointing at targets of arbitrary shapes. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 463-472.
- C70. Tovi Grossman, Daniel Wigdor, Ravin Balakrishnan. (2007). Exploring and reducing the effects of orientation on text readability in volumetric displays. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 483-492.
- C71. Tovi Grossman, Pierre Dragicevic, Ravin Balakrishnan. (2007). Strategies for accelerating on-line learning of hotkeys. *Proceedings of CHI 2007 – the ACM Conference on Human Factors in Computing Systems*. p. 1591-1600.
- C72. Jia Sheng, Ravin Balakrishnan, Karan Singh. (2006). An interface for 3D sculpting via physical proxy. *Proceedings of GRAPHITE 2006 – International Conference on Computer Graphics and Interactive Techniques in Australasia and Southeast Asia*. p. 213-220.
- C73. Abhishek Ranjan, Jeremy Birnholtz, Ravin Balakrishnan. (2006). An exploratory analysis of partner action and camera control in a video-mediated collaborative task. *Proceedings of CSCW 2006 – the ACM Conference on Computer Supported Cooperative Work*. p. 403-412. **[ACM CSCW 2006 Best Paper Honorable Mention Award]**
- C74. Clifton Forlines, Chia Shen, Daniel Wigdor, Ravin Balakrishnan. (2006). Exploring the effects of group size and display configuration on visual search. *Proceedings of CSCW 2006 – the ACM Conference on Computer Supported Cooperative Work*. p. 11-20.
- C75. Xiang Cao, Ravin Balakrishnan. (2006). Interacting with dynamically defined information spaces using a handheld projector and a pen. *Proceedings of UIST 2006 – the ACM Symposium on User Interface Software and Technology*. p. 225-234.
- C76. Daniel Wigdor, Darren Leigh, Clifton Forlines, Samuel Shipman, John Barnwell, Ravin Balakrishnan, Chia Shen. (2006). Under the table interaction. *Proceedings of UIST 2006 – the ACM Symposium on User Interface Software and Technology*. p. 259-268
- C77. Anastasia Bezerianos, Pierre Dragicevic, Ravin Balakrishnan. (2006). Mnemonic rendering: An image-based approach for exposing hidden changes in dynamic displays. *Proceedings of UIST 2006 – the ACM Symposium on User Interface Software and Technology*. p. 159-168. **[ACM UIST 2006 Best Student Paper Award, and one of 3 papers invited to a UIST reprise session at ACM SIGGRAPH 2007]**
- C78. Tovi Grossman, Ravin Balakrishnan. (2006). The design and evaluation of selection techniques for 3d volumetric displays. *Proceedings of UIST 2006 – the ACM Symposium on User Interface Software and Technology*. p. 3-12.
- C79. Clifton Forlines, Daniel Vogel, Ravin Balakrishnan. (2006). HybridPointing: Fluid switching between absolute and relative pointing with a direct input device. *Proceedings of UIST 2006 – the ACM Symposium on User Interface Software and Technology*. p. 211-220.
- C80. Tovi Grossman, Ravin Balakrishnan. (2006). An evaluation of depth perception on volumetric displays. *Proceedings of AVI 2006 – the Conference on Advanced Visual Interfaces*. p. 193-200.
- C81. Anand Agarawala, Ravin Balakrishnan. (2006). Keepin' it real: Pushing the desktop metaphor with physics, piles and the pen. *Proceedings of CHI 2006 – the ACM Conference on Human Factors in Computing Systems*. p. 1283-1292.

- C82. Daniel Wigdor, Chia Shen, Clifton Forlines, Ravin Balakrishnan. (2006). Effects of display position and control space orientation on user preference and performance. *Proceedings of CHI 2006 – the ACM Conference on Human Factors in Computing Systems*. p. 309-318.
- C83. Tovi Grossman, Ken Hinckley, Patrick Baudisch, Maneesh Agrawala, Ravin Balakrishnan. (2006). Hover widgets: Using the tracking state to extend the capabilities of pen-operated devices. *Proceedings of CHI 2006 – the ACM Conference on Human Factors in Computing Systems*. p. 861-870.
- C84. Abhishek Ranjan, Ravin Balakrishnan, Mark Chignell. (2006). Searching in audio: The utility of transcripts, dichotic presentation, and time-compression. *Proceedings of CHI 2006 – the ACM Conference on Human Factors in Computing Systems*. p. 721-730.
- C85. Michael Wu, Chia Shen, Kathy Ryll, Clifton Forlines, Ravin Balakrishnan. (2006). Gesture registration, relaxation, and reuse for multi-point direct-touch surfaces. *Proceedings of TableTop 2006 – The IEEE International Workshop on Horizontal Interactive Human Computer Systems*. p. 183-190.
- C86. Daniel Vogel, Ravin Balakrishnan. (2005). Distant freehand pointing and clicking on very large high resolution displays. *Proceedings of UIST 2005 – the ACM Symposium on User Interface Software and Technology*. p. 33-42.
- C87. Shahzad Malik, Abhishek Ranjan, Ravin Balakrishnan. (2005). Interacting with large displays from a distance with vision-tracked multi-finger gestural input. *Proceedings of UIST 2005 – the ACM Symposium on User Interface Software and Technology*. p. 43-52. [**One of 3 papers invited to a UIST reprise session at ACM SIGGRAPH 2006**]
- C88. Gonzalo Ramos, Ravin Balakrishnan. (2005). Zliding: Fluid zooming and sliding for high precision parameter manipulation. *Proceedings of UIST 2005 – the ACM Symposium on User Interface Software and Technology*. p. 143-152.
- C89. Clifton Forlines, Ravin Balakrishnan, Paul Beardsley, Jeroen van Baar, Ramesh Raskar. (2005). Zoom-and-Pick: Facilitating visual zooming and precision pointing with interactive handheld projectors. *Proceedings of UIST 2005 – the ACM Symposium on User Interface Software and Technology*. p. 73-82.
- C90. Michael McGuffin, Ravin Balakrishnan. (2005). Interactive visualization of genealogical graphs. *Proceedings of InfoVis 2005 – the IEEE Symposium on Information Visualization*. p. 17-24.
- C91. Theophanis Tsandilas, Ravin Balakrishnan. (2005). An evaluation of techniques for reducing spatial interference in single display groupware. *Proceedings of ECSCW 2005 – the European Conference on Computer Supported Cooperative Work*. p. 221-240.
- C92. Daniel Wigdor, Ravin Balakrishnan. (2005). Empirical investigation into the effect of orientation on text readability in tabletop displays. *Proceedings of ECSCW 2005 – the European Conference on Computer Supported Cooperative Work*. p. 205-224.
- C93. Xiang Cao, Ravin Balakrishnan. (2005). Evaluation of an online adaptive gesture interface with command prediction. *Proceedings of GI 2005 – the Graphics Interface Conference*. p. 187-194. [**GI 2005 Best Student Paper Award**]
- C94. Tovi Grossman, Ravin Balakrishnan. (2005). The Bubble Cursor: Enhancing target acquisition by dynamic resizing of the cursor's activation area. *Proceedings of CHI 2005 – the ACM Conference on Human Factors in Computing Systems*. p. 281-290. [**ACM CHI 2005 Best Paper Award**]
- C95. Anastasia Bezerianos, Ravin Balakrishnan. (2005). The Vacuum: Facilitating the manipulation of distant objects. *Proceedings of CHI 2005 – the ACM Conference on Human Factors in Computing Systems*. p. 361-370.
- C96. Daniel Vogel, Ravin Balakrishnan. (2004). Interactive public ambient displays: transitioning from implicit to explicit, public to personal, interaction with multiple users. *Proceedings of UIST 2004 – the ACM Symposium on User Interface Software and Technology*. p. 137-146.
- C97. Shengdong Zhao, Ravin Balakrishnan. (2004). Simple vs. compound mark hierarchical marking menus. *Proceedings of UIST 2004 – the ACM Symposium on User Interface Software and Technology*. p. 33-42.

- C98. Tovi Grossman, Daniel Wigdor, Ravin Balakrishnan. (2004). Multi-finger gestural interaction with 3D volumetric displays. *Proceedings of UIST 2004 – the ACM Symposium on User Interface Software and Technology*. p. 61-70. **[ACM UIST 2004 Best Paper Award, and one of 3 papers invited to a UIST reprise session at ACM SIGGRAPH 2005]**.
- C99. Karan Singh, Ravin Balakrishnan. (2004). Visualizing 3D scenes using non-linear projections and data mining of previous camera movements. *Proceedings of Afrigraph 2004 – the ACM African Graphics Conference*. p. 41-48.
- C100. Michael McGuffin, Gord Davison, Ravin Balakrishnan. (2004). Expand-ahead: A space-filling strategy for browsing trees affording faster drill-down. *Proceedings of InfoVis 2004 – the IEEE Symposium on Information Visualization*. p. 119-126.
- C101. Wael Aboelsaadat, Ravin Balakrishnan. (2004). An empirical comparison of transparency on one and two layer displays. *Proceedings of HCI 2004 – the British HCI Conference*. p. 53-67.
- C102. Steven Tsang, Ravin Balakrishnan, Karan Singh, Abhishek Ranjan. (2004). A suggestive interface for image guided 3D sketching. *Proceedings of CHI 2004 – the ACM Conference on Human Factors in Computing Systems*. p. 591-598.
- C103. Gonzalo Ramos, Matthew Boulos, Ravin Balakrishnan. (2004). Pressure widgets. *Proceedings of CHI 2004 – the ACM Conference on Human Factors in Computing Systems*. p. 487-494.
- C104. Tovi Grossman, Ravin Balakrishnan. (2004). Pointing at trivariate targets in 3D environments. *Proceedings of CHI 2004 – the ACM Conference on Human Factors in Computing Systems*. p. 447-454.
- C105. Daniel Wigdor, Ravin Balakrishnan. (2004). A comparison of consecutive and concurrent input text entry techniques for mobile phones. *Proceedings of CHI 2004 – the ACM Conference on Human Factors in Computing Systems*. p. 81-88.
- C106. Michael Wu, Ravin Balakrishnan. (2003). Multi-finger and whole hand gestural interaction techniques for multi-user tabletop displays. *Proceedings of UIST 2003 – the ACM Symposium on User Interface Software and Technology*. p. 193-202.
- C107. Daniel Wigdor, Ravin Balakrishnan. (2003). TiltText: Using tilt for text input to mobile phones. *Proceedings of UIST 2003 – the ACM Symposium on User Interface Software and Technology*. p. 81-90.
- C108. Gonzalo Ramos, Ravin Balakrishnan. (2003). Fluid interaction techniques for the control and annotation of digital video. *Proceedings of UIST 2003 – the ACM Symposium on User Interface Software and Technology*. p. 105-114.
- C109. Xiang Cao, Ravin Balakrishnan. (2003). VisionWand: Interaction techniques for large displays using a passive wand tracked in 3D. *Proceedings of UIST 2003 – the ACM Symposium on User Interface Software and Technology*. p. 173-182. **[One of 3 papers invited to a “Best of UIST” reprise session at ACM SIGGRAPH 2004]**
- C110. Michael McGuffin, Liviu Tancu, Ravin Balakrishnan. (2003). Using deformations for browsing volumetric data. *Proceedings of Vis 2003 – the IEEE Visualization Conference*. p. 401-408.
- C111. Tovi Grossman, Ravin Balakrishnan, Karan Singh. (2003). An interface for creating and manipulating curves using a high degree-of-freedom input device. *Proceedings of CHI 2003 – the ACM Conference on Human Factors in Computing Systems*. p. 185-192.
- C112. Nicholas Burtnyk, Azam Khan, George W. Fitzmaurice, Ravin Balakrishnan, Gordon Kurtenbach. (2002). StyleCam: Interactive stylized 3D navigation using integrated spatial & temporal controls. *Proceedings of UIST 2002 – the ACM Symposium on User Interface Software & Technology*. p. 101-110.
- C113. Michael McGuffin, Ravin Balakrishnan. (2002). Acquisition of expanding targets. *Proceedings of CHI 2002 – the ACM Conference on Human Factors in Computing Systems*. p. 57-64.
- C114. Tovi Grossman, Ravin Balakrishnan, Gordon Kurtenbach, George W. Fitzmaurice, Azam Khan, William Buxton. (2002). Creating principal 3D curves with digital tape drawing. *Proceedings of CHI 2002 – the ACM Conference on Human Factors in Computing Systems*. p. 121-128.

- C115. Tovi Grossman, Ravin Balakrishnan, Gordon Kurtenbach, George W. Fitzmaurice, Azam Khan, William Buxton. (2001). Interaction techniques for 3D modeling on large displays. *Proceedings of I3D 2001 – the ACM Symposium on Interactive 3D Graphics*. p. 17-23.
- C116. Ravin Balakrishnan, Ken Hinckley. (2000). Symmetric bimanual interaction. *Proceedings of CHI 2000 – the ACM Conference on Human Factors in Computing Systems*. p. 33-40.
- C117. Ravin Balakrishnan, Ken Hinckley. (1999). The role of kinesthetic reference frames in two-handed input performance. *Proceedings of UIST 1999 – the ACM Symposium on User Interface Software & Technology*. p. 171-178.
- C118. Ravin Balakrishnan, George W. Fitzmaurice, Gordon Kurtenbach, William Buxton. (1999). Digital tape drawing. *Proceedings of UIST 1999 – the ACM Symposium on User Interface Software & Technology*. p. 161-169.
- C119. Ravin Balakrishnan, Gordon Kurtenbach. (1999). Exploring bimanual camera control and object manipulation in 3D graphics interfaces. *Proceedings of CHI 1999 – the ACM Conference on Human Factors in Computing Systems*. p. 53-63.
- C120. George W. Fitzmaurice, Ravin Balakrishnan, Gordon Kurtenbach, William Buxton. (1999). An exploration into supporting artwork orientation in the user interface. *Proceedings of CHI 1999 – the ACM Conference on Human Factors in Computing Systems*. p. 167-174.
- C121. Ravin Balakrishnan, George W. Fitzmaurice, Gordon Kurtenbach, Karan Singh. (1999). Exploring interactive curve and surface manipulation using a bend and twist sensitive input strip. *Proceedings of I3D 1999 – the ACM Symposium on Interactive 3D Graphics*. p. 111-118.
- C122. Ravin Balakrishnan, Pranay Patel. (1998). The PadMouse: Facilitating selection and spatial positioning for the non-dominant hand. *Proceedings of CHI 1998 – the ACM Conference on Human Factors in Computing Systems*. p. 9-16.
- C123. Ravin Balakrishnan, Thomas Baudel, Gordon Kurtenbach, George W. Fitzmaurice. (1997). The Rockin'Mouse: Integral 3D manipulation on a plane. *Proceedings of CHI 1997 – the ACM Conference on Human Factors in Computing Systems*. p. 311-318.
- C124. Ravin Balakrishnan, I. Scott MacKenzie. (1997). Performance differences in the fingers, wrist, and forearm in computer input control. *Proceedings of CHI 1997 – the ACM Conference on Human Factors in Computing Systems*. p. 303-310.
- C125. Colin Ware, Ravin Balakrishnan. (1994). Target acquisition in fishtank VR: The effects of lag and frame rate. *Proceedings of the Graphics Interface Conference*. p. 1-7.

Refereed conference notes and short papers

- N1. Gerry Chu, Tomer Moscovich, Ravin Balakrishnan. (2009). Haptic conviction widgets. *Proceedings of GI 2009 – the Graphics Interface Conference*. p. 207-210.
- N2. Daniel Wigdor, Chia Shen, Clifton Forlines, Ravin Balakrishnan. (2006). Table-centric interactive spaces for real-time collaboration. *Proceedings of AVI 2006 – the Conference on Advanced Visual Interfaces*. p. 103-107.
- N3. Michael Tsang, Nigel Morris, Ravin Balakrishnan. (2004). Temporal thumbnails: rapid visualization of time-based viewing data. *Proceedings of AVI 2004 – the Conference on Advanced Visual Interfaces*. p. 175-178.

Conference abstracts, posters and demos

- 1. Jeremy Birnholtz, Abhishek Ranjan, Ravin Balakrishnan. (2008). Error and coupling: Extending common ground to improve the provision of visual information for collaborative tasks. *Conference of the International Communication Association, Montreal, Canada, May 22-26, 2008*.
- 2. Jeremy Birnholtz, Abhishek Ranjan, Ravin Balakrishnan. (2007). Using motion tracking data to augment video recordings in experimental social science research. *Proceedings of the Third International Conference on e-Social Science*.

3. Igor Mordatch, Patrick Coleman, Karan Singh, Ravin Balakrishnan. (2007). Interface techniques for 3D control of spatial keyframing. *Poster in ACM SIGGRAPH Conference*.
4. Daniel Wigdor, Chia Shen, Clifton Forlines, Ravin Balakrishnan. (2006). Table-centric interactive spaces for real-time collaboration: a video demonstration. *Video Proceedings of CSCW 2006 – the ACM Conference on Computer Supported Cooperative Work*.
5. Daniel Wigdor, Chia Shen, Clifton Forlines, Ravin Balakrishnan. (2006). Table-centric interactive spaces for real-time collaboration: Solutions, evaluation, and application scenarios. *Proceedings of CollabTech 2006*.
6. Ravin Balakrishnan, Colin Ware, Tim Smith. (1994). Virtual handtool with force-feedback. *Companion Proceedings of CHI 1994 – the ACM Conference on Human Factors in Computing Systems*. p. 83-84.

Technical Reports

1. Gonzalo Ramos, Ravin Balakrishnan. (2004). Visual features and interference in pressure widgets. Technical Report, DGP Lab, University of Toronto, DGP-TR-2004-003.
2. Anastasia Bezerianos, Ravin Balakrishnan. (2004). Interaction and visualization techniques for very large scale high resolution displays. Technical Report, DGP Lab, University of Toronto, DGP-TR-2004-002.

Theses

1. Ravin Balakrishnan. (2001). Issues in bimanual interaction for computer graphics. Ph.D. Thesis, Department of Computer Science, University of Toronto. February 2001.
2. Ravin Balakrishnan. (1997). The evolution and evaluation of a 3D input device. M.Sc. Thesis, Department of Computer Science, University of Toronto. January 1997.

Patents

1. Hrvoje Benko, Andrew Wilson, Billy Chen, Ravin Balakrishnan, Patrick Baudisch. (2015). Touch interaction with a curved display. *United States Patent #. 9,218,116*
2. Desney Tan, Daniel Morris, Scott Saponas, Ravin Balakrishnan. (2014). Recognizing finger gestures from forearm EMG signals. *United States Patent #. 8,892,479*
3. Desney Tan, Daniel Morris, Scott Saponas, Ravin Balakrishnan. (2013). Recognizing gestures from forearm EMG signals. *United States Patent #. 8,447,704*
4. Anand Agarawala, Ravin Balakrishnan. (2013). System for organizing and visualizing display objects. *United States Patent # 8,402,382*
5. Steve Tsang, Karan Singh, Abhishek Ranjan, Ravin Balakrishnan. (2012). Method, system and computer program for using a suggestive modeling interface. *United States Patent # 8,300,062*
6. Kentaro Toyama, Gerald Chu, Ravin Balakrishnan. (2012). Talking paper authoring tools. *United States Patent # 8,201,074*.
7. Ravin Balakrishnan, Gordon Kurtenbach, George Fitzmaurice. (2010). System for physical rotation of volumetric display enclosures to facilitate viewing. *United States Patent # 7724251*.
8. Gordon Kurtenbach, George Fitzmaurice, Ravin Balakrishnan. (2010). Volume management system for volumetric displays. *United States Patent # 7839400, 7,986,318*
9. Nicolas Burtnyk, Azam Khan, George Fitzmaurice, Ravin Balakrishnan, Gordon Kurtenbach. (2009). System and method of integrated spatial and temporal navigation. *United States Patent # 7589732*.
10. George Fitzmaurice, Ravin Balakrishnan, Gordon Kurtenbach. (2009). Widgets displayed and operable on a surface of a volumetric display enclosure. *United States Patent # 7554541*.
11. Clifton Forlines, Ravin Balakrishnan. (2009). Method and system for switching between absolute and relative pointing with direct input devices. *United States Patent # 7640518*.

12. Clifton Forlines, Ravin Balakrishnan. (2009). Method for stabilizing and precisely locating pointers generated by handheld direct pointing devices. *United States Patent #7486274*.
13. Ravin Balakrishnan, George Fitzmaurice, Gordon Kurtenbach. (2008). Techniques for pointing to locations within a volumetric display. *United States Patent # 7324085, 7,528,823*
14. Ravin Balakrishnan, George Fitzmaurice, Gordon Kurtenbach, Karan Singh. (2008). System for creating and modifying curves and surfaces. *United States Patent #7289121*
15. George Fitzmaurice, Ravin Balakrishnan, Gordon Kurtenbach. (2007). Graphical user interface widgets viewable and readable from multiple viewpoints in a volumetric display. *United States Patent #7205991*
16. Ravin Balakrishnan, Gordon Kurtenbach, George Fitzmaurice. (2006). System for physical rotation of volumetric display enclosures to facilitate viewing. *United States Patent #7138997*
17. Ravin Balakrishnan, Gordon Kurtenbach. (2005). A system for dynamically mapping input device movement as a user's viewpoint changes. *United States Patent # 6981229, 7,640,515*
18. Gordon Kurtenbach, George Fitzmaurice, Ravin Balakrishnan. (2004). Three dimensional volumetric display input and output configurations. *United States Patent #6753847, 7,583,252*
19. Ravin Balakrishnan, William Buxton, George W. Fitzmaurice, Gordon Kurtenbach. (2003). Digital tape drawing system. *United States Patent #6642927, 7,102,642*
20. Ravin Balakrishnan, Thomas Baudel, George W. Fitzmaurice, Gordon Kurtenbach. (2000). Three-dimensional input system using tilt. *United States Patent #6115028*.

Invited talks

Distinguished Lecture, University of New Brunswick, Faculty of Computer Science. Apr 2017.

Invited lecture, National University of Singapore. 26 Mar 2014. Host: Dr. Shengdong Zhao.

China HCI Symposium 2012. Invited distinguished Lecture. Chinese Academy of Sciences, Beijing, China. 18 June 2012. Hosts: Prof. Hongan Wang and Dr. Xiang Cao.

“Facile interaction with displays all over the place”. Invited lecture. Department of Computer Science, UOIT. Host: Dr. Faisal Qureshi. 26 Jan 2011.

“Facile interaction with displays all over the place”. Invited lecture. Department of Computer Science, Queens University. Host: Dr. Roel Vertegaal. 19 Jan 2010.

“Facile interaction with displays all over the place”. Colloquim. Department of Computer Science, Harvard University. Host: Dr. Chia Shen. 5 Mar 2009.

“Facile interaction with displays all over the place”. HP Labs India Lecture Series. Bangalore, India. 17 Feb 2009.

“Interacting with displays all over the place.” Invited talk at the UK-India Winter School on HCI. Bangalore, India. Host: Sriram Subramanian. 3 Feb 2009.

“Interacting with displays all over the place.” Invited talk at the McGill University CRMMRT Workshop on Multimodal Interaction. Host: Dr. Jeremy Cooperstock. 26 Sep 2008.

“Interacting with displays all over the place.” Invited talk at the iCORE Banff Informatics Summit. Host: Dr. Saul Greenberg and Dr. Sheelagh Carpendale. 22 Aug 2008.

“Towards more casual and realistic user interfaces.” Invited talk at HP Labs, Bangalore, India. Host: Dr. Sriganesh Madvanath. 20 Feb 2008.

“Towards more casual and realistic user interfaces.” Keynote talk at TECS Week, Pune, India. Host: Dr. Harrick Vin. 10 Jan 2008.

“Towards more casual and realistic user interfaces.” Keynote talk at Conference on Human-Machine Environments, Jinan, Shangdong Province, China. Host: Dr. Yuanchun Shi. 15 Oct 2008.

“Towards more casual ubiquitous interfaces.” Invited talk at Microsoft Research India, Bangalore. Host: Dr. Kentaro Toyama. 12 June 2007.

“Physics, projection, piles, and pens: user interfaces in the post GUI era.” Invited talk at Institute of Software, Chinese Academy of Sciences, Beijing. Host: Dr. Guozhong Dai. 5 Sep 2006.

“Physics, projection, piles, and pens: user interfaces in the post GUI era.” Invited talk at Tsinghua University, Beijing. Host: Dr. Yuanchun Shi. 1 Sept 2006.

“Physics, projection, piles, and pens: user interfaces in the post GUI era.” Invited talk at Microsoft Research Asia, Beijing. Host: Dr. Jian Wang. 30 Aug 2006.

“UI Projects at DGP lab”. Informal talk at Microsoft Research Cambridge. Host: Dr. Abigail Sellen. 12 July 2006.

“Physics, projection, piles, and pens: user interfaces in the post GUI era.” Invited talk at the University of Lille, France. Host: Prof. Gery Casiez. 10 July 2006.

“Physics, projection, piles, and pens: user interfaces in the post GUI era.” Invited talk at the iLog, France. Host: Dr. Thomas Baudel. 6 July 2006.

“Physics, projection, piles, and pens: user interfaces in the post GUI era.” Invited talk at LRI, University of Paris-Sud, France. Host: Prof. Michel Beaudouin-Lafon. 20 June 2006.

“Why aren’t we using 3D interfaces, and will we ever?” Keynote lecture, IEEE Symposium on 3D User Interfaces, 26 March 2006.

“Interaction and Visualization Techniques for Next-Generation Displays.” HCIL Colloquium, Department of Computer Science, University of Maryland, College Park. Host: Prof. Ben Bederson. 15 March 2005.

“Interaction Design for Future Computing Environments.” Colloquium, Department of Computer Science, University of Washington. Host: Prof. James Landay. 1 March 2005.

“Interaction and Visualization Techniques for Next-Generation Displays”. Distinguished Lecture, Department of Electrical Engineering and Computer Science, University of California, Berkeley. Host: Prof. John Canny. 17 Nov 2004.

“Usability challenges of large scale off-the-desktop interaction”. Invited talk at the IBM MITE Conference, Toronto, Canada. 4 Oct 2004.

“High degree-of-freedom interfaces”. Invited talk at the TTI/Vanguard Technology Transfer Symposium. Phoenix, Arizona: 3-4 Dec 2003.

“Non-wimp user interfaces”. Invited talk at IBM Centre for Advanced Studies. Host: Dr. Paul Smith. 26 Aug 2003.

“Fluid interaction techniques for the control and annotation of digital video”. Invited talk at Nokia Research Centre, Helsinki, Finland. Host: Miika Silfverberg. 9 May 2003.

“Interaction techniques for tabletop and volumetric displays”. Invited talk at Swedish National Defence College, Stockholm, Sweden. Host: S. Anders Christensson. 8 May 2003.

“Interaction with high degree-of-freedom input and next generation display technologies”. Invited lectures spanning 2 days at the University of Tampere, Tampere, Finland. Host: Prof. Kari-Jouko Rähkä. 5-6 May 2003.

“High degree-of-freedom interaction and visualization”. Presentation at an invitation-only workshop at the Banff Centre for the Arts, Banff, Alberta. Host: Sara Diamond. 12-15 Sep 2002.

“Multi-channel and multi degree-of-freedom interaction for computer graphics”. Invited talk at National Research Council, Ottawa. Host: Dr. Janice Singer. 20 Feb 2002.

“Devices and Interaction Techniques for Interfaces to 3D Graphics”. Invited talk at University Telekom, Melaka, Malaysia. Host: Dr. Abu Hasan Ismail, Dean. Dec 1998.

“Multi Stream and Multi Degree of Freedom Input for Desktop 3D Interaction”. Invited talk at Microsoft Research. Host: Dr. Ken Hinckley. 15 Oct 1998.

"Overview of Alias|wavefront User Interface Research Group's research projects". Presentation at Toron-Nihon Workshop organized by Dr. Paul Milgram at the University of Toronto. 19 Mar 1998.

Teaching

Graduate courses taught as a faculty member

CSC2604, "Topics in Human Centered and Interdisciplinary Computing", Sep – Dec 2023.

A research seminar in human-centered computing.

CSC2524, "Topics in Interactive Computing", Sep – Dec 2022.

A research seminar in human-computer interaction.

CSC2604, "Topics in Human Centered and Interdisciplinary Computing", Sep-Dec 2013.

A research seminar in human-centered computing. This year, the focus was on mobile and cyber-physical computing.

CSC2524, "Topics in Interactive Computing", Jan - Apr 2013.

A research seminar in human-computer interaction. This year, the focus was on mobile computing.

CSC2524, "Topics in Interactive Computing", Sep - Dec 2010.

A research seminar in human-computer interaction. This year, the focus was on next generation user interfaces.

CSC2524, "Topics in Interactive Computing", Sep - Dec 2006.

A research seminar in human-computer interaction. This year, the focus was on advanced "off-the-desktop" interfaces.

CSC2524, "Topics in Interactive Computing", Jan - Apr 2006.

A research seminar in human-computer interaction. This year, the focus was on interactive information visualization.

CSC2524, "Topics in Interactive Computing", Sep - Dec 2004.

A research seminar in human-computer interaction. This year, the focus was on audio and gesture based user interfaces and interaction techniques.

CSC2514, "Human-Computer Interaction", Sep - Dec 2004.

This is the same course as CSC428 (the second undergraduate course on Human-Computer Interaction). The graduate students taking the course were required to do a more substantial research paper.

CSC2524, "Topics in Interactive Computing", Sep - Dec 2003

A research seminar in human-computer interaction. This year, the focus was on sketch and gesture based user interfaces and interaction techniques.

CSC2514, "Human-Computer Interaction", Sep - Dec 2003.

CSC2524, "Topics in Interactive Computing", Sep - Dec 2002

A research seminar in human-computer interaction. This year, the focus was large and tabletop display user interfaces and interaction techniques.

CSC2514, "Human-Computer Interaction", Sep - Dec 2002.

CSC2514, "Human-Computer Interaction", Sep - Dec 2001

Undergraduate courses taught as a faculty member

CSC490, "Capstone Design Project", Sep - Dec 2006.

CSC490, "Capstone Design Project", Sep 2005 - Apr 2006.

CSC490, "Capstone Design Project", Sep 2004 - Apr 2005.

4th year undergraduate course. This is a new course I proposed and developed last year that has students working on substantial projects spanning several areas of computer science.

CSC428, "Human-Computer Interaction", Sep - Dec 2004
 4th year undergraduate course. This second Human-Computer Interaction course at Toronto builds on the department's first course in HCI, CSC318. While the focus in CSC318 is largely on the design process, this second course focuses more on the underlying models of human-computer interaction, rigorous formal evaluation techniques, and research frontiers

CSC490, "Capstone Design Project", Sep 2003 - Apr 2004.

CSC428, "Human-Computer Interaction", Sep - Dec 2003

CSC428, "Human-Computer Interaction", Sep - Dec 2002

CSC318, "The Design of Interactive Computational Media", Jan - Apr 2002
 3rd year undergraduate course on methodologies for designing and evaluating user interfaces. The first course on Human-Computer Interaction at the University of Toronto.

CSC428, "Human-Computer Interaction", Sep - Dec 2001

Undergraduate courses taught while I was a graduate student

CSC258, "Computer Organization", May - Aug 2000.
 2nd year undergraduate course on digital logic design, machine languages, and computer system organization fundamentals.

CSC258, "Computer Organization", Jan - Apr 2000.

CSC258, "Computer Organization", Sep - Dec 1999.

CSC108, "Introduction to Computer Programming", May - Aug 1999.
 1st programming course for computer science undergraduates, taking an object-oriented approach using Java.

CSC258, "Computer Organization", Jan - Apr 1999.

CSC340, "Information Systems Analysis and Design", Sep - Dec 1998.
 3rd year undergraduate course on theory, tools, and techniques for information systems analysis and design.

CSC258, "Computer Organization", May - Aug 1998.

CSC340, "Information Systems Analysis and Design", Sep - Dec 1997.

CSC104, "The How and Why of Computing", Jan - Apr 1997.
 1st year undergraduate course in computing for non computer science students.

CSC258, "Computer Organization", May - Aug 1995.

Teaching assistantships while I was a graduate student

CSC428, "Human Computer Interaction", Sep - Dec 1996.

CSC228, "File Structures and Data Management", Sep - Dec 1995, Jan - Apr 1995.

CSC258, "Computer Organization", Jan - Apr 1996, Sep - Dec 1994, May - Aug 1994, Jan - Apr 1994, Sep - Dec 1993.

Academic advising

Current Ph.D. students

Laura Di Chen, Jan 2018 – ongoing, Co-advised with Tovi Grossman

Former postdoctoral fellows

1. Priyank Chandra, 2019 – 2021. Co-advised with Syed Ishtiaque Ahmed.
2. Fanny Chevalier, Jan 2012 – Nov 2013, co-advised with Karan Singh and Sara Diamond.
3. Thomas Pietrzak, Jan 2011 – Sep 2011, sole advisor
4. William Soukoreff, May 2010 – Nov 2011, sole advisor
5. Seok-Hyung Bae, Sept 2007 – Feb 2010, co-advised with Karan Singh.
6. Tomer Moscovich, Feb 2007 – June 2008.
7. Jeremy Birnholtz, Sep 2005 – July 2007, co-advised with Ron Baecker, Saul Greenberg, Carl Gutwin.
8. Géry Casiez, Feb - Aug 2005
9. Pierre Dragicevic, Feb 2006 – Apr 2007.

Graduated Ph.D. students

1. Jiannan Li. Graduated 2023. Co-advised with Tovi Grossman
Thesis: “Robotic Tools for Interactive Viewpoint Control in Video Communication”
2. Aakar Gupta, Graduated 2018. Sole advisor.
Thesis: “Extended Hand Attributes for Touch Input, Touch Output and Touchless Interaction”
3. Sajad Shirali-Shahreza. Graduated 2017. Co-advised with Yashar Ganjali.
Thesis: “FleXight: Flexible Information Channel for Software-Defined Networking”
4. Rorik Henrikson, Graduated 2016. sole advisor.
Thesis: “Facilitating Real-Time Sketch-Based Storyboards for Stereoscopic and Virtual Reality Environments”
5. Dustin Freeman. Graduated 2015, sole advisor
Thesis: “Improv Remix: A system for Improv Theatre Performers to record and re-project Stage Video using wholebody interaction”
6. Jian Zhao. Graduated Apr 2015, sole advisor
Thesis: “Interactive visual data exploration: a multi-focus approach”
7. Xiaojun Bi. Graduated June 2011, sole advisor
Thesis: “Processing desktop work on a large high-resolution display: studies and designs”
8. Daniel Vogel. Graduated April 2010, sole advisor.
Thesis: “Direct pen input and hand occlusion”. Received award for best Canadian thesis in HCI for 2011.
9. Clifton Forlines. Graduated Nov 2008, sole advisor
Thesis: “User interfaces for visual search”
10. Abhishek Ranjan. Graduated Oct 2008, sole advisor
Thesis: “Automatic camera control for capturing collaborative meetings”
11. Xiang Cao. Graduated Oct 2008, sole advisor
Thesis: “Handheld projector interaction”
12. Tovi Grossman. Graduated Apr 2008, sole advisor
Thesis: “Interaction with volumetric displays”
13. Daniel Wigdor. Graduated Apr 2008, sole advisor
Thesis: “The design of table-centric interactive spaces”
14. Gonzalo Ramos. Graduated Jan 2008, sole advisor
Thesis: “Pressure sensitive pen interactions”
15. Anastasia Bezerianos. Graduated Sept 2007, sole advisor

Thesis: “Designs for single user, up-close interaction with wall-sized displays”

16. Michael McGuffin. Graduated May 2007, sole advisor

Thesis: “An investigation of issues and techniques in highly interactive computational visualization”

Graduated masters students

(note: prior to 2007, the master’s degree at Toronto required a formal thesis; since 2007, the thesis is optional and a research paper can be submitted instead).

1. Laura Di Chen. Graduated Jan 2018, sole advisor.
Research paper: “Learning by Interacting: an Investigation of Multi-Modal Communication in Live Streaming for Language Learning”.
2. Rinat Abdrashitov. Graduated Jan 2015. co-advised with Karan Singh.
Research paper: “Interactive Shape Modeling using a Skeleton-Mesh Co-Representation”.
3. Jonathan Deber. Graduated Jan 2013, sole advisor
Research paper: “Métamorphe: augmenting hotkey usage with actuated keys”.
4. Stephanie Santosa. Graduated Jan 2013. co-advised with Karan Singh
Research paper: “Direct space-time trajectory control for visual media editing”.
5. Aakar Gupta. Graduated Jan 2012, sole advisor
Research paper: “mClerk: Enabling Mobile Crowdsourcing in Developing Regions”.
6. Rorik Henrikson. Graduated Jan 2012, sole advisor
Research paper: “An exploration of multi-user games using projector phones”.
7. Navkar Samdaria, Graduated Jan 2012, sole advisor
Research paper: “Paying in kind for crowdsourced work in developing regions”.
8. Mohit Jain. Graduated Jan 2011, sole advisor
Research paper: “An exploratory study of mobile collaborative learning in developing regions”.
9. Akhil Mathur. Graduated Jan 2011, sole advisor
Research paper: “An exploratory study of a cameraphone-projector system”.
10. Dustin Freeman. Graduated Sep 2010, sole advisor.
Research paper: “Tangible Actions: More efficient direct multitouch through replaying gestures”.
11. Dominika Ruszkowski. Graduated Sep 2010, sole advisor.
Research paper: “Exploring user adaptability of mouse and touch in the desktop environment”.
12. Patrick Dubroy. Graduated May 2009, sole advisor
Research paper: “A field study on the use of tabs in Mozilla Firefox”.
13. Azam Khan. Graduated Sep 2008, sole advisor
Research paper: “ViewCube: A 3D orientation indicator and controller”.
14. Michael Jurka. Graduated Jan 2008, sole advisor
Research paper: “Visualizing user activity to enhance document retrieval”.
15. Gerald Chu. Graduated Dec 2007, sole advisor
Research paper: “Haptic conviction widgets”
16. Tristan Campbell. Graduated Oct 2006, sole advisor
Thesis: “MCurve: A crossing based system for graphical music composition”
17. Steven Tsang. Graduated Aug 2006, co-advised with Karan Singh.
Thesis: “A sketch based 2D animation system using dynamic motion hierarchies”
18. Anand Agarawala. Graduated Jan 2006, sole advisor
Thesis: “Pushing the desktop metaphor with physics, piles and the pen”

19. Daniel Vogel. Graduated Jan 2005, sole advisor
Thesis: "Interactive public ambient displays"
20. Jia Sheng, Graduated Jan 2005, co-advised with Karan Singh.
Thesis: "A gestural 3D modeling interface using fingers and a physical prop tracked in 3D"
21. Abhishek Ranjan. Graduated Jan 2005, sole advisor
Thesis: "Browsing archived meeting audio and time-synchronized data"
22. Wael Aboelsaadat. Graduated Jan 2004, sole advisor
Thesis: "Evaluation of a transparent two-layer display"
23. Xiang Cao. Graduated Jan 2004. co-advised with Allan Jepson.
Thesis: "An exploration of gesture-based interaction"
24. Tovi Grossman. Graduated Jan 2004, sole advisor
Thesis: "Alternate user interfaces for the manipulation of curves in 3D environments"
25. Daniel Wigdor. Graduated Jan 2004, sole advisor
Thesis: "Chording and tilting for rapid, unambiguous text entry to mobile phones"
26. Yan (Grace) Wang. Graduated Dec 2003, sole advisor
Thesis: "Selection techniques for laser pointer interaction"
27. Michael McGuffin. Graduated Aug 2002, co-advised with Gordon Kurtenbach
Thesis: "Fitts' law and expanding targets: an experimental study, and applications to user interface design"

Ph.D. thesis committees

Karin Nieuwenhuizen. 2015. Department of Industrial Design, Eindhoven University of Technology. PhD external examiner. Advisor: Martens Jean-Bernard

Abir Mohammed Al Hajri. 2014. Department of Electrical Engineering, University of British Columbia. PhD external examiner. Advisor: Sid Fels.

Michael Gluek. 2012- present. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Daniel Wigdor

Marc Fiume. 2012- 2014. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Michael Brudno

Carrie Demmans Epp. 2012- 2015. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Ron Baecker

Vincent Cheung. 2013. Department of Electrical and Computer Engineering, University of Toronto. Ph.D. Thesis committee member. Advisor: Brendan Frey.

Felipe Bacim, 2011-2015. Department of Computer Science, Virginia Tech. Ph.D. Thesis committee member. Advisor: Doug Bowman.

Mathieu Nancel. 2012. University of Paris, Sud. Ph.D. Thesis external reader. Advisor: Michel Beaudoin-Lafon.

William Soukoreff. 2010. York University. Ph.D. Thesis External Examiner. Advisor: Scott MacKenzie.

Craig Tashman, 2009 – 2012. GVU Centre, Georgia Tech. Ph.D. Thesis committee member. Advisor: Keith Edwards.

Regis Kopper. 2008 - 2012. Department of Computer Science, Virginia Tech. Ph.D. Thesis committee member. Advisor: Doug Bowman.

Michael Daum. 2006 – 2011. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Karan Singh.

David Dearman. 2006 – 2011. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Khai Truong.

Bowen Hui. 2003 – 2011. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Craig Boutilier

Shahzad Malik. 2005 – 2007. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Allan Jepson.

Iqbal Mohamed. 2005 – 2008. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Eyal de Lara.

Tao Ni. 2006 - 2011. Department of Computer Science, Virginia Tech. Ph.D. Thesis committee member. Advisor: Doug Bowman.

Koji Yatani. 2006 – 2011. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Khai Truong

Shengdong Zhao. 2004 – 2008. Department of Computer Science, University of Toronto. Ph.D. Thesis committee member. Advisor: Mark Chignell.

Maciej Kalisiak. 2002 - 2006. Department of Computer Science. Thesis committee member. Advisor: Michiel van de Panne

Wenbi Wang. 2004. Department of Mechanical and Industrial Engineering. Thesis defense committee member. Advisor: Paul Milgram.

Second reader for masters theses advised by others

Peter Hamilton. 2013. Advisor: Daniel Wigdor

Michael Glueck. 2012. Advisor: Daniel Wigdor

Frank Li. 2011. Advisor: Khai Truong

Yannick Thiel. 2011. Advisor: Karan Singh

James McCrae. 2008. Advisor: Karan Singh

Noah Lockwood. 2006. Advisor: Karan Singh

Naiqi Weng. 2005. Advisor: Karan Singh

Krista Strickland. 2005. Advisor: Ron Baecker

Xia Liu. 2004. Advisor: Karan Singh

Iqbal Mohamed. 2004. Advisor: Eyal de Lara

Michael Tsang. 2002. Advisor: Bill Buxton & George Fitzmaurice

Nicolas Burtnyk. 2002. Advisor: Bill Buxton

Undergraduate research students

Muhammad Anwar. Sep 1 2015 – Apr 30 2016. Engineering Science thesis.

Phoebe Chang. 1 May – 31 Aug 2013. (NSERC USRA award).

Curren Pangler, 1 May – 31 Aug 2007 (NSERC USRA award), co-advised with my postdoc Tomer Moscovich.

Sameer Vohra, 1 May – 31 Aug 2007 (NSERC USRA award), co-advised with my postdoc Tomer Moscovich.

Nicholas Kong, 1 May - 31 Aug 2005, 1 May - 31 Aug 2006 (NSERC USRA Award), 1 May – 31 Aug 2007 (NSERC USRA award), co-advised with my PhD student Tovi Grossman.

Matthew Boulos, 1 May - 31 Aug 2003 (NSERC USRA award) and 1 May - 31 Aug 2004 (NSERC USRA award), co-advised with my PhD student Gonzalo Ramos

Vikas Jain, Intern from IIT Bombay, 1 May - 31 July 2003, sole advisor
Tovi Grossman, 1 May - 31 Aug 2002 (NSERC USRA award), sole advisor
Jeffrey Magder, 1 May - 31 Aug 2002 (NSERC USRA award), sole advisor
Abhishek Ranjan, Intern from IIT Bombay, 1 May - 31 July 2002, sole advisor
Plus roughly 20 other undergraduates informally advised on various research activities in my lab.

Undergraduate project course supervision

(these are undergraduate research projects for which the student gets a CSC494/495 course credit or an Engineering Thesis)

Elaine Wong, Sep 2009 – Apr 2010.
Janek Biczysko-Lasocki, Jan – Apr 2007, co-advised with my PhD student Xiang Cao
Jacky Jie Li, Jan – Apr 2007, co-advised with my PhD student Xiang Cao
Phillip Mach, Jan – Apr 2007, co-advised with my PhD student Abhishek Ranjan
Clarence Chan, Jan - Apr 2004, co-advised with my PhD student Daniel Wigdor.
Steve Tsang, Sep - Dec 2002, sole advisor
Jeffrey Magder, Sep - Dec 2002, sole advisor
Daniel Wigdor, Jan - Apr 2002, sole advisor
Simone Maillard, Jan - Apr 2002, sole advisor
Tovi Grossman, Jan - Apr 2002, sole advisor
Wai Shan Lau, Jan - Apr 2002, sole advisor
Casson Ming Tse Lee, Jan - Apr 2002, sole advisor
Tovi Grossman, May - Aug 2000, co-advised with Gordon Kurtenbach.

Service outside the university

Journal, conference and workshop chairing and organization

ACM Transactions on Computer-Human Interaction. Associate Editor, 2010 – present.
Springer Computer Science HCI Series, Editorial Board, 2013-present.
Mobile HCI 2012, Doctoral Consortium Chair.
IEEE Transactions on Visualization and Computer Graphics. Associate Editor, 2008 – 2011.
ACM UIST 2009 Symposium on User Interface Software and Technology, Sponsorship Chair.
IEEE 3DUI 2009 Symposium on 3D User Interfaces. Conference Co-Chair.
ACM UIST 2008 Symposium on User Interface Software and Technology, Sponsorship Co-Chair.
Human-Computer Interaction journal. Co-editor of Special Issue on Ubiquitous Multi Display Environments. 2007-2008.
ACM UIST 2007 Symposium on User Interface Software and Technology, Program Chair.
ACM UIST 2007 Symposium on User Interface Software and Technology, Sponsorship Co-Chair.
Ubicomp 2005 Workshop on "The Spaces in-between: Seamful vs. Seamless Interactions". Co-organizer.
Graphics Interface 2004 Conference, Conference and Program Co-Chair

Graphics Interface 2002 Conference, Posters and Demonstrations Chair

International Input Research Workshop, Ribeaucourt, France, Apr 2000. Organizing Committee.

Conference and workshop program committees

ACM SIGGRAPH Conference on Computer Graphics and Interactive Techniques (2010).

ACM CHI Conference on Human Factors in Computing Systems, Associate Chair for Papers (2002, 2003, 2004, 2005, 2006, 2009, 2010, 2011, 2013, 2015).

ACM CHI Conference on Human Factors in Computing Systems, Short Papers Program Committee (2001)

International Projector-Camera Systems Workshop (PROCAMS), Program Committee (2008).

ACM SIGGRAPH International Conference on Virtual-Reality Continuum and its Applications in Industry (VRCAI), Program Committee (2008).

ACM UIST Symposium on User Interface Software and Technology, Papers Committee (2003, 2004, 2005, 2006, 2010, 2015). Doctoral symposium committee (2010).

Graphics Interface Conference, Papers Program Committee (2002).

ACM VRST Symposium on Virtual Reality Software and Technology, Full Papers Program Committee (2003).

IUI International Conference on Intelligent User Interfaces, Workshop on Intelligent User Interfaces for Developing Regions, Program Committee (2008).

IEEE InfoVis Symposium on Information Visualization, Papers Program Committee (2006).

ACM I3D Symposium on Interactive 3D Graphics and Games, Papers Program Committee (2006).

NordiCHI Conference, Papers Program Committee (2004).

8th Eurographics Workshop on Virtual Environments, Barcelona, Spain, Papers Program Committee (2002).

5th International Projector-Camera Systems Workshop (PROCAM), Program Committee (2008).

HCI track for CISIS2009, International Conference on Complex, Intelligent and Software Intensive Systems, Fukuoka, Japan. Program Committee (2009).

ACM Dev Conference (2010).

Paper & manuscript refereeing

ACM CHI Conference on Human Factors in Computing Systems (1998, 1999, 2000, 2001, 2007, 2008, 2011, 2013)

ACM UIST Symposium on User Interface Software and Technology (2001, 2002, 2008, 2009, 2013)

ACM SIGGRAPH Conference on Computer Graphics and Interactive Techniques (2001, 2002, 2003, 2004)

ACM I3D Symposium on Interactive 3D Graphics (2001, 2003)

ACM Transactions on Computer Human Interaction (2002, 2004, 2005, 2007, 2008)

ACM Conference on Universal Usability (2000)

ACM Computing Surveys (2008)

Communications of the ACM (1999)

Eurographics Conference (2003, 2004, 2005)

Graphics Interface Conference (1998, 2003, 2005, 2010, 2011)

Human Computer Interaction journal (2005, 2006)

IBM Systems Journal (1997)

IEEE Computer (2004)
IEEE Transactions on Visualization and Computer Graphics (2004, 2005, 2006, 2007)
IEEE Computer Graphics and Applications (2005, 2006)
IEEE InfoVis Symposium on Information Visualization (2005)
Interact Conference (1999, 2000)
Information Visualization journal (2007)
International Journal of Human Computer Studies (2001, 2005, 2006, 2008)
Journal of New Music Research (2003)
MIT Press book review (2005, 2006)
Morgan Kaufmann Press book review (2006).
Ubicomp Conference (2006)
Wiley Press book review (2003)

Grant & fellowship reviewing

NSERC Discovery Grants review committee (2013-2015).
Ontario Ministry of Research and Innovation Grant review (2008)
Netherlands Organisation for Scientific Research, grant review (2008).
Austrian Erwin Schroedinger fellowship review (2008).
Swiss National Science Foundation grant reviews (2007)
NSERC New Media Grant review (2004)
NSERC Strategic Grant reviews (2002, 2003, 2004)
NSERC Discovery Grant reviews (2003, 2004, 2005, 2006)
CFI Grant review (2007)

External organizations, tenure and promotion reviews

External reviewer for one tenure case at the University of Lugano (2013).
External reviewer for INRIA's graphics, interaction and visualization research teams (2010).
External reviewer for one tenure case at the University of North Carolina, Charlotte (2010).
External reviewer for one full professor promotion case at York University. (2010)
External reviewer for one tenure case at Harvard University. (2009)
External reviewer for one appointment renewal case at the University of North Carolina, Charlotte. (2008)
External reviewer for one tenure case at the University of California, Berkeley. (2008)
External reviewer for one tenure case at Nanyang Technological University, Singapore. (2007).
External reviewer for one tenure case at the University of Paris-Sud. (2007)

Other activities

ACM UIST 2005 Session Chair
ACM CHI 2002 Conference Session Chair

ACM CHI 2001 Conference Session Chair

Member of Association for Computing Machinery (ACM)

Service within the University of Toronto

Research and Industrial Relations Committee chair, Department of Computer Science, 2013-2014 academic year.

Faculty recruiting committee, Department of Computer Science, 2013-2014 academic year.

Graduate Admissions Committee., Department of Computer Science, 2012-2013 academic year.

PTR Committee., Department of Computer Science, 2010-2011 academic year.

Professional Masters committee, Department of Computer Science, 2009-2010 academic year.

PTR Committee., Department of Computer Science, 2009-2010 academic year.

Committee developing a proposal for a new “EDU-C” unit at the university called the Information and Communications Forum. Led by Prof. Alberto Leon-Garcia. 2008-2009 academic year.

Faculty recruiting committee, Department of Computer Science, 2008-2009 academic year.

Professional Masters committee, Department of Computer Science, 2008-2009 academic year.

Tenure committee for one tenure case at the Department of Mechanical and Industrial Engineering, 2009.

Evaluation committee for one 3rd year faculty review case at the Department of Computer Science, 2008.

Tenure committee for one tenure case at the Department of Computer Science, 2007.

Teaching evaluation committee for one tenure case at the Department of Computer Science, 2007.

Faculty recruiting committee, Department of Computer Science, 2006-2007 academic year.

Initiated and ran a seminar series on research skills and related topics intended for all graduate students in the department. The seminars are archived at: <http://www.dgp.toronto.edu/~ravin/gradskillsseminars2007/>

Graduate admissions committee, Department of Computer Science, 2005-2006 academic year.

Faculty recruiting committee for a HCI position, Department of Computer Science, 2004-2005 academic year.

Online graduate applications system: I took the lead on developing this system for the Department of Computer Science, Sept 2004 – May 2006.

Graduate admissions committee, Department of Computer Science, 2004-2005 academic year.

Graduate admissions committee, Department of Computer Science, 2003-2004 academic year.

Graduate breadth evaluation committee, Department of Computer Science, 2003-2004 academic year.

Graduate breadth evaluation committee, Department of Computer Science, 2002-2003 academic year.

Undergraduate committee, Department of Computer Science, 2002-2003 academic year.

Faculty support staff committee, Department of Computer Science, 2002-2003 academic year.

Department computing committee, Department of Computer Science, 2002-2003 academic year.

Faculty recruiting committee, Department of Computer Science, 2002-2003 academic year.

Department of Computer Science “planning discussion paper” committee, responsible for putting together a discussion paper on the direction of the department over the next 5-10 years. Apr-May 2003.

Environment and equity committee, Department of Computer Science, 2001-2002 academic year.

Initiated and organized, together with Kyros Kutulakos, Karan Singh, and Sam Roweis, the first visit of potential graduate students to the department. Feb-Mar 2002. I was also involved in organizing the event the next year (2003).

Initiated and organized a new process for graduate student recruiting where we invite short-listed candidates to visit us for a combined interview/recruitment event, *before* admission offers are made. We have found this to be a very successful process for making more informed admissions decisions. First organized in 2003 for the HCI group, then expanded to Graphics and HCI in 2004, and since then other groups in the department have begun to adopt this approach as well.

From July 2001 to September 2006, I was responsible for the day-to-day direction and management (including supervision of 1 full-time and 1 part-time technical staff members) of the Dynamic Graphics Project laboratory (www.dgp.toronto.edu), which is home base to the department's graphics and HCI faculty and graduate students (7 faculty, 50 students).

Graphics and HCI seminar coordinator, Department of Computer Science, 2001-2002, 2002-2003, 2003-2004, 2004-2005, 2005-2006 academic years.