

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE, INC.
Petitioner

v.

IMMERVISION, INC.
("ImmerVision"),
Patent Owner

Case IPR2023-00471
Patent No. 6,844,990

SECOND DECLARATION OF DR. DAVID KESSLER, Ph.D.

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I. INTRODUCTION

1. My name is Dr. David Kessler, and I have been retained by counsel for Petitioner Apple Inc. (“Apple” or “Petitioner”) as an expert witness to provide assistance regarding U.S. Patent No. 6,844,990 (the “’990 Patent”). Specifically, I have been asked to consider the validity of claims 27, 2, 4, 29, and 30 of the ’990 Patent (“Challenged Claims”) in view of prior art, obviousness considerations, understanding of a person of ordinary skill in the art at the time of the invention (“POSITA”) as it relates to the ’990 Patent, and Patent Owner ImmerVision, Inc.’s Patent Owner Response (and associated exhibits, including the declaration of ImmerVision’s expert, Mr. James Munro).

2. I am being compensated for my time at my standard consulting rate. I am also being reimbursed for expenses that I incur during the course of this work. My compensation is not contingent upon the results of my study, the substance of my opinions, or the outcome of any proceeding involving the challenged claims. I have no financial interest in the outcome of this matter or on the pending litigation between Petitioner Apple Inc. and Patent Owner ImmerVision, Inc.

3. My analysis here is based on my years of education, research, and experience, as well as my investigation and study of relevant materials, including those cited herein.

4. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the Patent Owner. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

5. This declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

II. BACKGROUND AND QUALIFICATIONS

6. My education and experience are described more fully in the attached *curriculum vitae* (APPLE-1004). For ease of reference, I have highlighted certain information below.

7. I have over forty years of academic and industry experience in optics. I am proficient in several topics/fields, including, e.g., aberrations theory, physical optics, optical systems architecture and design, and major optical CADs.

8. Since 2006, I have been the owner of Kessler Optics & Photonics Solutions Ltd., which provides consulting services relating to optical designs and optical systems architecture primarily in imaging systems; projection systems; display technologies; AR/VR systems; medical imaging systems like digital retina

and cornea microscopes; intra oral cameras based on mobile phone cameras; military digital simulators and more.

9. For most of the period between 1982 and 2006, I managed an advanced optical design team at Kodak Research Labs. During my time at Kodak Research Labs, my projects included, among others, designing and developing digital cameras, designing of anti-aliasing filters for cameras, designing medical digital imaging systems like digital fundus CCD cameras, CCD scanners, laser systems including some using f-theta lenses, designing scan/process/print systems (where films were scanned, digitally processed to correct color, grain, exposure and artifacts, and then printed to paper at high speeds).; The first digital cinema projectors; Extended depth of focus (EDOF) cameras (where phase filters are introduced into the camera lens , images captured and algorithms used to resurrect the image with a resulting extended focus range;

10. I am a recipient of a Tech Emmy Award for the high-speed CCD scanner for real time telecine (system for conversion of a movie from film to HD video).

11. My full portfolio and my current projects are on my web site at www.KesslerOptics.com.

12. While at Kodak, I taught advanced optical design over two academic years as a visiting professor at Tel-Aviv University. More recently, I have conducted a number of advanced optical designs courses for corporate optical design teams.

13. I have a Bachelor of Science (BSc.) in physics and mathematics from The Hebrew University of Jerusalem. I have a Master of Science degree (MSc.) in physics and electro-optics from the School of Applied Sciences and Technology at The Hebrew University of Jerusalem. I have a Ph.D. in optical sciences from the Optical Sciences Center at the University of Arizona. My dissertation title is “Image quality criteria in the presence of moderately large aberrations” (which are the criteria to be chosen for usage in the merit function while optimizing lenses and other optical systems).

14. Additionally, I have familiarity with image processing algorithms. For example, as part of my Ph.D. program at the Optical Sciences Center at the University of Arizona, I studied under Prof. J. Gaskill who is the author of “Linear Systems Fourier Transformations in Optics.” Indeed, my dissertation deals with merit functions used in optical CAD programs that are associated with processing algorithms for image improvement.

15. Further still, a number of projects I led and/or participated in required post-capture image processing, some of which are referenced below:

16. Central photofinishing labs at Kodak where film was scanned and the scanned image was then processed using image processing algorithms to correct for defects in, e.g., correct exposure, low contrast, color gamut, grain, and resolution and printed at rates of 10,000 an hour;

17. I also analyzed and worked on Extended Depth of Focus (EDOF) cameras. These cameras, such as by CDM, DBLUR, XCEED and others, use phase elements in the camera to intentionally aberrate the captured images, which are then processed using image processing algorithms to retrieve the image at an increased depth of focus.

18. In lenticular imaging (also referred to as dynamic imaging) where about 30 images are combined as thin stripes at a focal plane of the lenticular lenses, we used image processing algorithms for the assembly of the images to provide a motion sensation;

19. In the laser printer space—which was one of my major activities in the first 14 years at Kodak—image interpolation algorithms were routinely used to facilitate correction for distortion.

20. Additionally, in a paper I published with colleagues, which is titled “Continuous tone printing using LCOS” (Digest of the Technical Papers, SID International Symposium, Vol. XXXVII, Page 174-177, June 2006), we described dithering and interpolation algorithms to significantly increase the resolution.

Relatedly, there are additional four papers on my site at <http://www.kessleroptics.com/publications>, dealing with multi spot laser printers or multichannel printers where interleaving was used and image processing was center to the ability to produce clean contiguous prints. In another paper on my website under “presentations,” and which is titled ”Image Quality Issues: the Optical Designer Point of View,” the issue of artifacts is covered and I discuss there the mitigation of such artifacts by either optical means or by image processing.

21. I also have designed and analyzed a number of Light Field (LF) cameras and microscopes for the two modalities of LF systems, namely temporal and spatial. Notably, LF systems rely heavily on image processing algorithms to capture images over a large depth of field.

22. I am a named inventor on 104 U.S. patents, almost all related to optical systems and imaging systems and have been a listed author on 25 papers.

23. I am a fellow of the SPIE, the International Society of Optical Engineering, and I am a member of organizations such as OPTICA and SID.

III. LEVEL OF ORDINARY SKILL IN THE ART

24. In my opinion, a person of ordinary skill in the art (“POSITA”) relating to, and at the time of, the ’990 Patent’s Critical Date would have had at least a Bachelor’s degree in Physics, Optical Engineering, and/or Electrical Engineering

and at least five years of experience in developing and designing optical imaging systems and have familiarity with image processing algorithms and optical design software. Additional education in a relevant field, or relevant industry experience may compensate for a deficit in one of the other aspects of the requirements stated above. APPLE-1003, ¶24.

25. Based on my knowledge, skill, and experience, I have a good understanding of the capabilities of the POSITA. Indeed, I have taught, participated in organizations, recruited, and worked closely with many such persons over the course of my career. For example, from my industry experience, I am familiar with what an engineer would have known and found predictable in the art. From teaching and supervising my post-graduate students, I also have an understanding of the knowledge that a person with this academic experience possesses. Furthermore, I possess those capabilities myself.

26. ImmerVision's expert, Mr. Munro, notes that he "does not necessarily agree" with this proposed skill level of a POSITA (EX-2001, ¶25). Mr. Munro does not explain what part of the above definition he "does not necessarily agree with" nor does he offer any alternative skill level of a POSITA. *See id.*

IV. MATERIALS CONSIDERED AND RELIED UPON

27. In reaching the conclusions described in this declaration, I have relied on the documents and materials referenced below as well as those identified in this declaration (and my earlier declaration, APPLE-1003), including the '990 Patent, the prosecution history of the '990 Patent, and prior art references cited and discussed herein. These materials include patents, related documents, and printed publications. Each of these materials is a type of document that experts in my field would have reasonably relied upon when forming their opinions.

28. I have also relied on my education, training, research, knowledge, and personal and professional experience in the relevant technologies and systems that were already in use prior to, and within the timeframe of the earliest priority date of the claimed subject matter in the '990 Patent, which I have been informed by counsel is May 11, 2001 ("Critical Date").

- APPLE-1001: U.S. Patent No. 6,844,990 ("the '990 patent")
- APPLE-1002: Prosecution History of the '990 Patent ("Original Prosecution History")
- APPLE-1006: U.S. Patent No. 5,686,957 to Baker ("Baker")
- APPLE-1007: "Fish Eye Lens" by K Miyamoto (Feb. 19, 1964) ("Miyamoto")
- APPLE-1009: U.S. Patent No. 3,953,111 to Fisher et al. ("Fisher")
- APPLE-1010: U.S. Patent No. 6,128,145 to Nagaoka ("Nagaoka")

- APPLE-1011: Reexamination File History of the '990 Patent (“Reexam History”)
- APPLE-1012: EP 1028389 to Shiota et al. (“Shiota”)
- APPLE-1013: Rebiai et al., “Image Distortion from Zoom Lenses: Modeling and Digital Correction,” 1992 IBC International Broadcasting Convention (July 1992) (“Rebiai”)
- APPLE-1014: JP 2000-242773 to Matsui et al. (“Matsui”)
- APPLE-1015: U.S. Patent No. 5,861,999 to Tada (“Tada”)
- APPLE-1016: Zeljko Andreic, “A simple 180° field-of-view F-theta all-sky camera,” SPIE Proc. 1500 (Oct. 1, 1991) (“Andreic”)
- APPLE-1017: Abed Kassim et al., “Optical Performance of axial gradient and aspheric surface lenses: study and analysis,” SPIE’s 1994 International Symposium on Optics, Imaging, and Instrumentation, Vol. 2263 (Sept. 30, 1994) (“Kassim”)
- APPLE-1018: Susan Houde-Walter, “Recent Progress In Gradient-Index Optics,” SPIE Proc. 0935 (Apr. 8, 1988) (“Houde-Walter”)
- APPLE-1020: Paul K. Manhart et al., “Fundamentals of macro axial gradient index optical design and engineering,” SPIE Opt. Eng. 36(6), 1607-1621 (June 1997) (“Manhart”)
- APPLE-1024: U.S. Patent No. 4,364,643 to Momiyama (“Momiyama”)
- APPLE-1026: Excerpts from “Modern Lens Design,” textbook authored by Warren J. Smith (1992 edition)
- APPLE-1027: J. Weng, “Motion and Structure from Line Correspondences: Closed-Form Solution, Uniqueness, and Optimization,” IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 14, No. 3 (Mar. 1992)

29. In addition, I have also reviewed the Patent Owner Response (“Response” or “POR”) submitted by ImmerVision, the declaration (EX-2001) of ImmerVision’s expert (Mr. James F. Munro), the materials cited in the Response and Mr. Munro’s declaration, and the deposition testimony of Mr. Munro (APPLE-1025).

The below table from the POR summarizes the materials cited there:

Exhibit No.	Description
2001	Declaration of James F. Munro
2002	Excerpt from Tinku Acharya & Ajoy K. Ray, <i>Image Processing Principles and Applications</i> (2005) (pp. 23-25)
2003	EV76C560 CMOS Image Sensor Datasheet from e2v Semiconductors SAS (2011)
2004	Excerpt from Michael P. Keating, <i>Geometric, Physical, and Visual Optics</i> (2 nd Ed. 2002) (pp. 347-350)
2005	U.S. Patent Application Publication No. 2004/0201764

V. LEGAL STANDARDS

A. Legal Standards for Prior Art

30. I understand that a patent or other publication must first qualify as prior art before it can be used to invalidate a patent claim.

31. I understand that a U.S. or foreign patent qualifies as prior art to a patent if the date of issuance of the U.S. or foreign patent is prior to the invention of the patent. I further understand that a printed publication, such as an article published in a magazine or trade publication, qualifies as prior art to a patent if the date of

publication is prior to the invention of the patent. My understanding is that, for such prior art references, a patentee may attempt to show that the claimed invention was conceived prior to the issuance of the U.S. foreign patent or publication of the printed materials. To do so, it is my understanding that patentee must prove with corroborating evidence that the named inventors conceived of the complete claimed invention before the prior art and were diligent in reducing the claimed inventions to practice.

32. I understand that, regardless of the date of invention of the patent, a U.S. or foreign patent qualifies as prior art to a patent if the date of issuance of the U.S. or foreign patent is more than one year before the earliest effective filing date of the patent. I further understand that a printed publication, such as an article published in a magazine or trade publication, constitutes prior art to a patent if the publication occurs more than one year before the earliest effective filing date of the patent, again regardless of the date of invention of the patent.

33. I understand that a U.S. patent or published U.S. application qualifies as prior art to a patent if the application for that patent was filed in the United States before the invention of the patent. My understanding is that, for such prior art references, a patentee may attempt to show that the claimed invention was conceived prior to the filing in the United States of the purported prior art U.S. patent or application. To do so, it is my understanding that patentee must prove with

corroborating evidence that the named inventors conceived of the complete claimed invention before the prior art and were diligent in reducing the claimed inventions to practice.

34. I understand that to qualify as prior art, a reference must contain an enabling disclosure that allows one of ordinary skill to practice the claims without undue experimentation.

35. I understand that documents and materials that qualify as prior art can be used to invalidate a patent claim as anticipated or as obvious.

B. Legal Standard for Priority Date

36. I understand that the “priority date” or “earliest effective filing date” of a patent is the date on which it is filed, or the date on which an earlier-filed U.S. or international patent application was filed if the patentee claims the benefit of priority to that earlier-filed U.S. or international patent application. I further understand that although a foreign priority document may be used to try to overcome certain prior art references, the effective filing date is not the filing date of a foreign priority document.

C. Legal Standard for Obviousness

37. My understanding is that a patent claim is invalid as obvious only if the subject matter of the claimed invention “as a whole” would have been obvious to one of ordinary skill at the time the invention was made. To determine the

differences between a prior art reference (or a proposed combination of prior art references) and the claims, the question of obviousness is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. Also, obviousness grounds cannot be sustained by mere conclusory statements. Rather, it is necessary to provide some articulated reasoning with rational underpinning to support the legal conclusion of obviousness.

38. I understand that a patent claim that comprises several elements is not proved obvious by simply showing that each of its elements was independently known in the prior art. In my evaluation of whether any claim of the '990 Patent would have been obvious, I considered whether the Petition, or any evidence submitted in this proceeding, presented an articulated reason with a rational basis that would have motivated one of ordinary skill to combine the elements or concepts from the prior art in the same way as in the claimed invention.

39. It is my understanding that there is no single way to define the line between true inventiveness on one hand—which is patentable—and the application of common sense and ordinary skill to solve a problem on the other hand—which is not patentable. For instance, factors such as market forces or other design incentives may be the source of what produced a change, rather than true inventiveness.

40. I understand that the decision-maker may consider whether the change was merely the predictable result of using prior art elements according to their

known functions, or whether it was the result of true inventiveness. And, the decision-maker may also consider whether there is some teaching or suggestion in the prior art to make the modification or combination of elements recited in the claim at issue. Also, the decision-maker may consider whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way. The decision-maker may also consider whether the claimed invention would have been obvious to try, meaning that the claimed innovation was one of a relatively small number of possible approaches to the problem with a reasonable expectation of success by those skilled in the art.

41. I have been instructed by counsel that if any of these considerations are relied upon to reach a conclusion of obviousness, the law requires that the analysis of such a consideration must be made explicit. I understand that the decision-maker must be careful not to determine obviousness using the benefit of hindsight and that many true inventions might seem obvious after the fact. I understand that the decision-maker should consider obviousness from the position of one of ordinary skill at the time the claimed invention was made, and that the decision-maker should not consider what is known today or what is learned from the teaching of the patent.

42. I understand that in order to determine whether a patent claim is obvious, one must make certain factual findings regarding the claimed invention and the prior art. Specifically, I understand that the following factors must be evaluated

to determine whether a claim is obvious: the scope and content of the prior art; the difference or differences, if any, between the claim of the patent and the prior art; the level of ordinary skill in the art at the time the claimed invention was made; and, if available, the objective indicia of non-obviousness, also known as “secondary considerations.”

43. I understand that the secondary considerations include: commercial success of a product due to the merits of the claimed invention; a long felt need for the solution provided by the claimed invention; unsuccessful attempts by others to find the solution provided by the claimed invention; copying of the claimed invention by others; unexpected and superior results from the claimed invention; acceptance by others of the claimed invention as shown by praise from others in the field or from the licensing of the claimed invention; teaching away from the conventional wisdom in the art at the time of the invention; independent invention of the claimed invention by others before or at about the same time as the named inventor thought of it; and other evidence tending to show obviousness.

44. I understand that, to establish a secondary consideration, the evidence must demonstrate a nexus between that secondary consideration and the claimed invention.

VI. GROUND 1: BAKER IN VIEW OF SHIOTA RENDERS OBVIOUS CLAIM 27

45. Claim 27 of the '990 Patent recites:

27. A method for displaying a digital panoramic image, the method comprising:

obtaining a digital panoramic image by projecting a panorama onto an image sensor using a panoramic objective lens, the panoramic objective lens having an image point distribution function that is not linear relative to a field angle of object points of the panorama, the distribution function having a maximum divergence of at least $\pm 10\%$ compared to a linear distribution function, such that the panoramic image obtained has at least one substantially expanded zone and at least one substantially compressed zone; and

displaying the obtained panoramic image by correcting the non-linearity of the initial image, performed by retriev-

ing image points on the obtained image in a coordinate system of center O' using at least the non-linear distribution function and a size L of the obtained image.

46. As explained in my original declaration (APPLE-1003), the combination of Baker and Shiota renders obvious claim 27. See APPLE-1003, ¶¶128-213.

47. I understand that ImmerVision's arguments are limited to limitation [27f], which recites that "correcting the non-linearity of the initial image" is "performed by retrieving image points on the obtained image in a coordinate system of center O' using at least the non-linear distribution function and a size L of the obtained image." See POR, 1-2, 14-19; EX-2001, ¶¶49-58.

48. To demonstrate obviousness of this limitation, my original declaration leveraged teachings of the Shiota reference as applied in combination with the teachings of the Baker reference. APPLE-1003, ¶¶191-213, 128-139; see Petition, 45-55, 22-27. ImmerVision and its expert (Mr. Munro) appear to argue that the Baker-Shiota combination has not been shown to render this claim feature obvious. POR, 1-2, 14-19; EX-2001, ¶¶49-58. I disagree.

49. As explained below, ImmerVision and its expert incorrectly characterize my testimony as mapping the claim feature of “size L of the obtained image” to only Shiota’s reference to “magnification adjustment” in paragraph 23 of its disclosure. This characterization ignores the surrounding context of paragraph 23 in Shiota as well as my testimony explaining how Shiota’s teachings would have rendered obvious using the actual image size (i.e., using size L of the obtained image, as claimed) as part of the image transformation/correction. I also explain below that the proposed combination of Baker and Shiota operate in a manner commensurate with how the ’990 Patent’s specification describes performing the correction of non-linearity of the image using the size L of the image, as recited in claim 27.

A. ImmerVision’s Arguments Rely on Mischaracterizations of the Evidence and My Earlier Testimony

50. **First**, ImmerVision characterizes my testimony as follows:

Shiota’s paragraph [0023] concludes by discussing how the radius of the fisheye image is set to 1. Ex. 2001 at ¶ 51. The final

sentence recites that “[a]t the time of actually (sic) use, magnification adjustment is performed.” Ex. 1012 at ¶ [0023]; Ex. 2001 at ¶ 51. Dr. Kessler conclusorily leaps to the assumption that a POSA would have understood this to be an adjustment that accounts for the actual size of the image.³ Ex. 1003 at ¶ 205.

POR, 15; EX-2001, ¶¶50-51; see POR, 15 (similarly stating that “Petitioner and Dr. Kessler rely on Shiota’s reference to ‘magnification’ ... as evidence of the [] claim element” reciting “retrieving image points on the obtained image ... using at least ... a size L of the obtained image”).

51. This mischaracterizes my testimony because it omits key portions of Shiota’s cited disclosures that formed the basis for this testimony. The cited testimony (which is excerpted in part below) confirms I was relying on at least the following disclosures in Shiota, teaching that: (1) the image circle diameter varies/differs according to the size of the image pickup device, **and** (2) while a normalized radius of 1 is assumed at a field angle of 90 degrees, “magnification adjustment” is performed “at the time of actual[] use” as part of Shiota’s image transformation operations that retrieve the corrected image points:

Testimony in First Declaration (APPLE-1003, ¶¶205-206)¹	Cited Disclosure in Shiota (APPLE-1012, [0023] (annotated))
<i>For its described image transformation operations, Shiota assumes a normalized radius of 1 of the image circle at a field angle of 90° (from the front of the lens). APPLE-1012, [0023]. However, Shiota acknowledges that the image circle diameter (i.e., the size of the image) “differs according to at least the size of the [CCD] image pickup device” (the size of the image disk/sensor) and that “at the time of actual use, magnification adjustment is performed.” Id.</i>	[0023] A plane image (fisheye image) obtained through the fisheye lens is expressed by a (p, q) coordinate system as shown in Fig. 1. It is assumed that the (p, q) coordinate system is parallel to the (X, Y) plane and has the origin on the Z axis. In a position on an image pickup face (for example, position of a pixel on a CCD image pickup device), the image circle diameter differs according to the size of the image pickup device and the focal distance of the fisheye lens. Consequently, it is assumed that a fisheye image is projected in a circle of radius 1 of an image of an object positioning at 90 degrees (Z = 0) from the front of the lens. At the time of actually use, magnification adjustment is performed.

52. **Second**, ImmerVision and its expert state that magnification is a “dimensionless quantity” and that “Dr. Kessler offers no explanation as to how or why a POSA would have initially understood from Shiota’s reference to a dimensionless number that Shiota suggests using the claimed linear quantity for retrieving image points and correcting image distortion.” POR, 16; see EX-2001, ¶¶50-52. Again, this argument rests on the incorrect premise that my testimony for this claim feature is exclusively limited to Shiota’s reference to “magnification adjustment.”

¹ Emphasis added unless otherwise noted.

53. As such, ImmerVision fails to give proper weight and consideration to the entirety of my testimony for this limitation, which when considered in its proper context, demonstrates how the above-described teachings in Shiota, as applied in combination with Baker, would have rendered obvious using the non-linear distribution function and the size of the image to retrieve corrected image points for display.

54. As I have explained, Shiota's image transformation algorithm uses a non-linear image distribution function, which Shiota refers to as the quantity "h" representing a "height" from "the origin on the fisheye image face" to "the point w" as expressed as a function of theta. *See* APPLE-1012, [0036]-[0042]; APPLE-1003, ¶¶120-121, 201-206. A POSITA would have understood that height as referred to in Shiota refers to image height or radial distance and that the angle theta refers to the field angle. *See also* APPLE-1025, 18:13-19:13 (testifying that that image height and distance are equivalent in the field of optics).

55. Shiota further states that the image size or radius, which is image height, h, at a field angle of 90 degrees, is normalized to 1. APPLE-1012, [0023]; APPLE-1003, ¶¶205-206. Specifically, Shiota states that "it is assumed that a fisheye image is projected in a circle of radius 1 of an image of an object position[ed] at 90 degrees ($Z=0$) from the front of the lens." APPLE-1012, [0023]. Thus, the height of the image ($h = f(\theta)$ or $h = 2f * \tan(\theta/2)$, where $\theta = 90$ degrees) is 1 when the radius is

assumed/normalized to 1. See APPLE-1012, [0036]-[0037] (showing and describing image distribution functions for computing image height of particular coordinates at particular field angles).

56. Because Shiota's image distribution function uses a normalized image size/radius of 1, this function therefore identifies heights of image points normalized on a scale ranging from 0 to 1. APPLE-1003, ¶¶205-206; APPLE-1025, 15:5-17:8. In other words, because image height or distance is computed using a function that uses a normalized image size of 1, the image height/distance using Shiota's image distribution function would be provided in relative terms, on a scale ranging from 0 to 1. Note that image size is a well-recognized term in the fields of optics and optical design, and in the context of circular images, image size is commonly referenced using the radius or diameter of the image circle. Of course, a circle's diameter (d) is just two times the circle's radius (r) (i.e., $d = 2r$). The interrelatedness of these concepts (image circle radius and image circle diameter) to an image's size is confirmed, e.g., by Shiota, which discusses normalized image circle of radius 1 and recognizes that sizes of images (i.e., of the image circles) vary in actual use given that image circle diameter differs with size of the image pickup device. See APPLE-1012, [0023]; see APPLE-1025, 16:5-15, 37:18-38:6 (Mr. Munro testifying that size of image is the distance from the optical axis to the extent of the image, which is the radius of a circular image).

57. Notably, such normalization of image size (and other parameters, e.g., focal length) to 1 was well known and common in optics. This is corroborated by, e.g., APPLE-1009, FIGS. 3 and 4 (similarly depicting an image distribution function showing “normalized image height” ranging from 0 to 1); APPLE-1024, FIGS. 1-3, 2:6-8; APPLE-1026, p. 53 (full field normalized to 1.0), p. 199 (showing full field/image size normalized to 1 and showing the image height of obtained image (referenced as GIH or Gaussian Image Height) as 52.94 mm); APPLE-1027, p. 320 (describing scaling to “obtain a normalized camera model” that does not lose “generality” and in which the “focal length is one” and “[v]isible objects are always located in front of the camera, i.e., $z > 0$. ($z \leq 1$ can occur since the focal length is normalized.)”). ImmerVision’s expert, Mr. Munro, confirmed that normalizing the image size to 1 was “commonly done throughout the field of optics and lens” because “it makes the math more generic” (since “it is now independent of actual image size”), “applicable to wider range of lens configuration” and “easier to communicate” image heights “on that scale of 0 to 1.” APPLE-1025, 21:9-22:8, 23:6-24:10.

58. Further still, before May 2001, the use of normalized image size of 1 was prevalent in optical design. In fact, optical design programs (e.g., Zemax, CodeV or Oslo) commonly used normalized field size (namely image sizes). For example, these programs use merit function editors that are used in the process of

optimizing lenses and optical systems and which include “operands.” The most common operands are ray operands—namely, the position of a certain ray from a certain field point and a certain aperture position at a certain optical surface. In the optical design programs, it was (and is) common for the field coordinates used in the merit functions to be normalized and similarly, it was (and is) common for the pupil coordinates to be normalized, with the full field designated as a dimensionless, normalized value of 1.0.

59. While acknowledging that image heights are normalized on a scale of 0 to 1 to make the math “independent of actual image size,” Mr. Munro further confirmed—what is also well known in the fields of optics and optical design—that, “when you are considering an actual application, then you would have to scale up to account for the actual image size.” APPLE-1025, 23:14-24:10; *see id.* APPLE-1026, pp. 53, 57 (describing scaling and adjusting lens designs for actual applications); *see also* APPLE-1027, p. 320 (describing scaling to “obtain a normalized camera model” in which the “focal length is one” and where “[v]isible objects are always located in front of the camera, i.e., $z > 0$. ($z \leq 1$ can occur since the focal length is normalized.)”).

60. Consistent with this well-established practice in optics of scaling normalized image heights using the actual size of the image to obtain actual points of an image, the Baker-Shiota combination renders obvious computing corrected

image points using a non-linear distribution function, which uses a normalized image size of 1, and scaling using the actual image size to obtain the corrected, actual image points.

61. In particular, I explained in my first declaration that Shiota uses the non-linear distribution function in computing its correction coefficient (k_2) that is used to obtain corrected image points for display. APPLE-1003, ¶202 (citing APPLE-1012, ¶¶[0022]-[0024], [0037]-[0042]). Although the heights of the image points obtained using this distribution function are normalized values (given that the function uses a normalized image size/radius 1), Shiota also recognizes that, as part of its image transformation, “projection coordinates” (image points) on the “image pickup face are obtained” APPLE-1012, [0023], [0036]-[0042]; APPLE-1003, ¶¶191-213. A POSITA would have therefore recognized that, retrieving the coordinates/points on the image pickup face (and within the projected image circle) would involve retrieving image points on the actual image circle projected on an actual image sensor/image pickup device—and not the image circle that has a radius/size normalized to 1. *See id.*

62. This is expressly acknowledged by Shiota when it states that “[i]n a position on an image pickup face (for example, position of a pixel on a CCD image pickup device), the ***image circle diameter differs according to the size of the image pickup device and the focal distance of the fisheye lens.***” APPLE-1012, [0023];

APPLE-1003, ¶¶205-206. And, as a result, although Shiota normalizes the image circle to a radius of 1, Shiota unequivocally states that “magnification adjustment is performed” “[a]t the time of actual[] use” to account for the differing image circle diameter (which differs according to image sensor size) in an actual application/use of Shiota’s system. *Id.*

63. Thus, given Shiota’s express teaching that size of the image pickup device (and by extension size of the image) varies/differs depending on the implementation, and because Shiota’s image transformation is illustrated using a normalized image size of 1, my testimony was and remains that “a POSITA would have found it obvious” to perform scaling or “magnification adjustment”—which, again, was common and conventional in optics—by “us[ing] the actual size of the image” to obtain the corrected image points for display. *Id.*

64. **Third**, ImmerVision and its expert characterize my prior testimony as “link[ing]” certain operator selected parameters described in paragraphs 24 and 26 of Shiota as relating to the magnification adjustment referenced in Shiota’s paragraph 23. POR, 1-2, 16-19; EX-2001, ¶¶53-56. This is incorrect.

65. I cited to paragraphs 24 to 26 for their summary teachings of Shiota’s overall image transformation process (see APPLE-1003, ¶205), which is further elaborated upon throughout the analysis for the present limitation (limitation [27f]) in my original declaration. See APPLE-1003, ¶¶191-213; see also *id.*, ¶151

(similarly citing Shiota’s paragraphs 22-26 as well as 37-42 to reference Shiota’s image transformation process).

66. Moreover, ImmerVision and its expert acknowledge that these allegedly operator-selected parameters in paragraphs 24 to 26 of Shiota relate to the “plane image” referenced in Shiota (expressed in u,v coordinates) (see POR, 17-19; EX-2001, ¶¶53-56)—and not to the obtained image on the image pickup face (expressed in p, q coordinates) that Shiota refers to as the “fisheye image.” APPLE-1012, [0023]-[0024].

67. However, paragraph 23 of Shiota confirms that the Shiota’s references to the “image circle diameter,” the normalized/assumed radius of 1 of the projected “circle,” and the “magnification adjustment” due to “the image circle diameter differ[ing] according to the size of the image pickup device”—all relate to the fisheye image obtained on the image pickup device and represented using (p,q) coordinates (which corresponds to the “obtained image” on the “image sensor,” as recited in claim 27). APPLE-1003, ¶¶205-206; see *id.*, APPLE-1012, [0023]-[0024].²

² It is worth noting that Shiota makes two references to “plane image”: (1) “a plane image (fisheye image) obtained through the fisheye lens,” which “is expressed by a (p, q) coordinate system” and (2) “a point (u, v coordinates) on a plane image.”

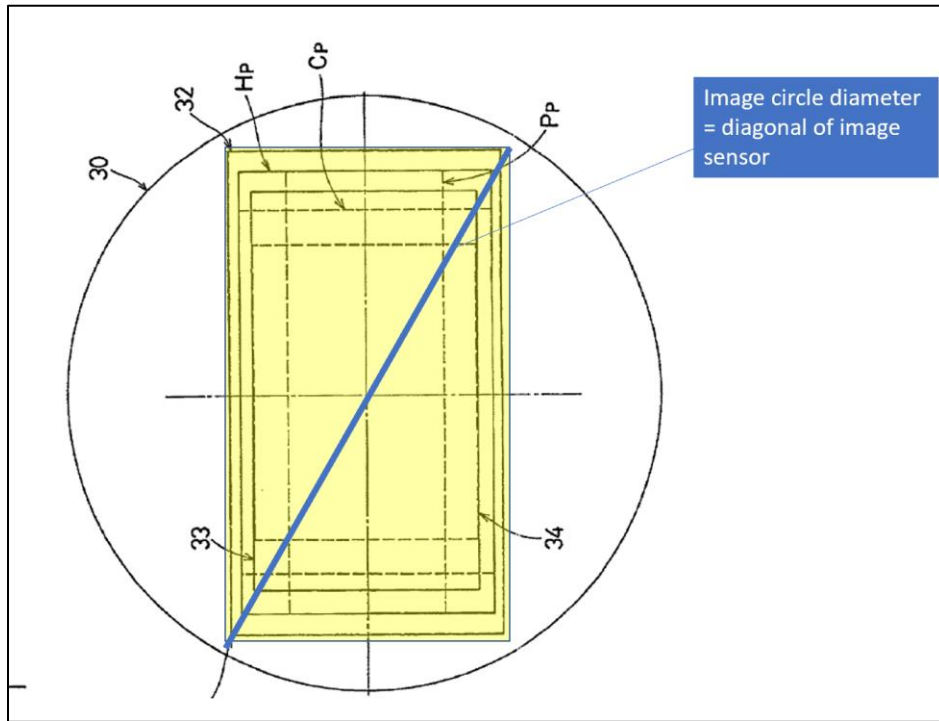
68. **Fourth**, ImmerVision argues in footnote 1 of the POR that size of the image sensor and size of the image are “not so inextricably linked.” POR, 15-16 n. 1; EX-2001, ¶58. I disagree. As a starting point, this assertion is refuted by Shiota, which teaches that the image circle diameter (which corresponds to the image size) differs according to the size of the image pickup device (i.e., the size of image sensor). APPLE-1012, [0023] (“In a position on an image pickup face (CCD image pickup device), the *image circle diameter differs according to the size of the image pickup device* and the focal distance of the fisheye lens.”). Thus, Shiota itself teaches image size and sensor size are directly related.

69. That the image size may not be exactly the same as the size of the sensor is beside the point—and I did not claim such equality between sensor size and image size. APPLE-1003, ¶¶205-206.

70. Moreover, consistent with Shiota’s teachings, a POSITA would have recognized the direct relationship between image size and sensor size. In fact, this is illustrated by the reference identified by Mr. Munro. Specifically, Mr. Munro identified Fig. 11 of U.S. Patent Application Publication US 2004/0201764 (EX-

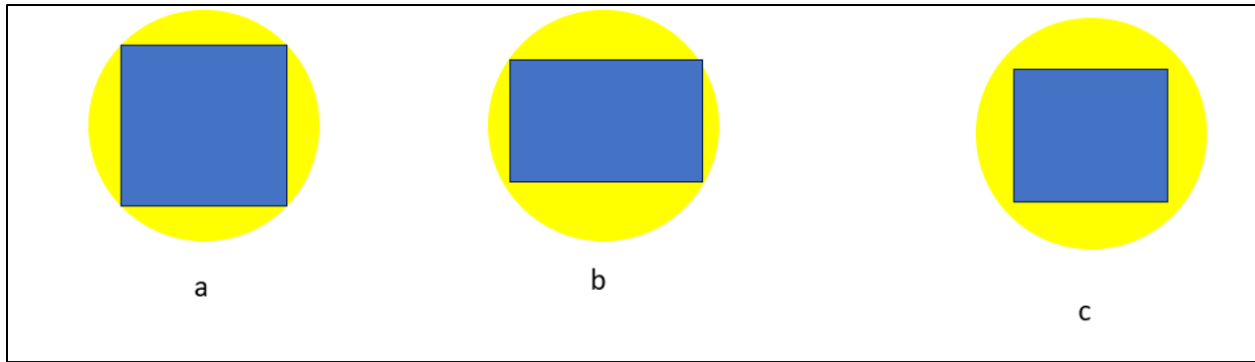
APPLE-1012, [0023]-[0024]. Shiota’s teachings in paragraph 23 are referring to the former—i.e., the “fisheye image.” See APPLE-1012, [0023].

2005), which shows the image sensor (highlighted in yellow below) and image circle/image disk (annotated with blue line), as reproduced and annotated below.



71. As shown above, the image circle's diameter is the same or nearly the same size as the diagonal of the rectangular sensor.

72. It was well known that the projected image is typically circular and is obtained on a rectangular sensor that has a certain aspect ratio (namely, width over height ratio)— this is corroborated by the above example provided by Mr. Munro. Depending on the application/implementation, a POSITA in this field recognized that the sensor size and aspect ratio are generally aligned or matched so that the image sensor has a diagonal that is the same as or similar to the image circle's diameter. Examples of such applications are shown below:



Option (a) above shows the sensor aspect ratio of 1:1, with the sensor diagonal being same in size as image circle diameter. Option (b) above shows the sensor aspect ratio of 16:9 (similar to FIG. 11 above in Mr. Munro's identified patent application), with the sensor diagonal here also being same in size as image circle diameter. Option (c) above shows the sensor aspect ratio of 4:3, with the sensor diagonal being roughly 0.8 times the size of the image circle diameter. Each of these options allows using all or most pixels of the image sensor. Note also that option (b) above (which is similar to FIG. 10 of the application cited by Mr. Munro) is a common implementation choice because it provides for a rectangular display and a relatively good utilization of the image area.

73. Thus, consistent with Shiota's teaching, a POSITA in this field would have readily understood that the image circle diameter differs according to (and therefore is directly related to) the size of the rectangular image pickup/sensor.

74. Mr. Munro also stated in his declaration that FIG. 2 of the '990 Patent shows an example of “underfilling” “where the image 3 does not cover the entire image sensor and leaves dark edges 4.” EX-2001, ¶58.

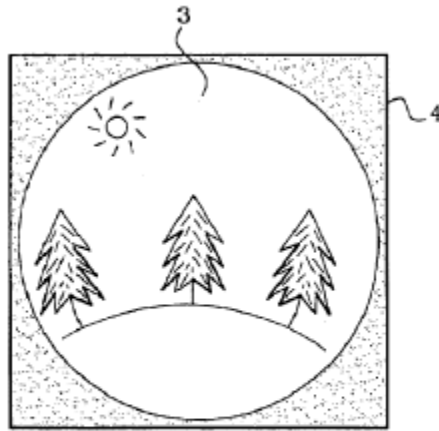


Fig. 2

75. However, this assertion was contradicted by his testimony during deposition. Specifically, during deposition, Mr. Munro confirmed that FIG. 2 actually “does not show the image sensor,” and that the dark edges 4 just highlight the “fact that” the image is round and is overlaid on a square, so “the corners of that square would be dark” and represent “the distortion that are objectionable that need to be removed.” APPLE-1025, 46:3-48:18.

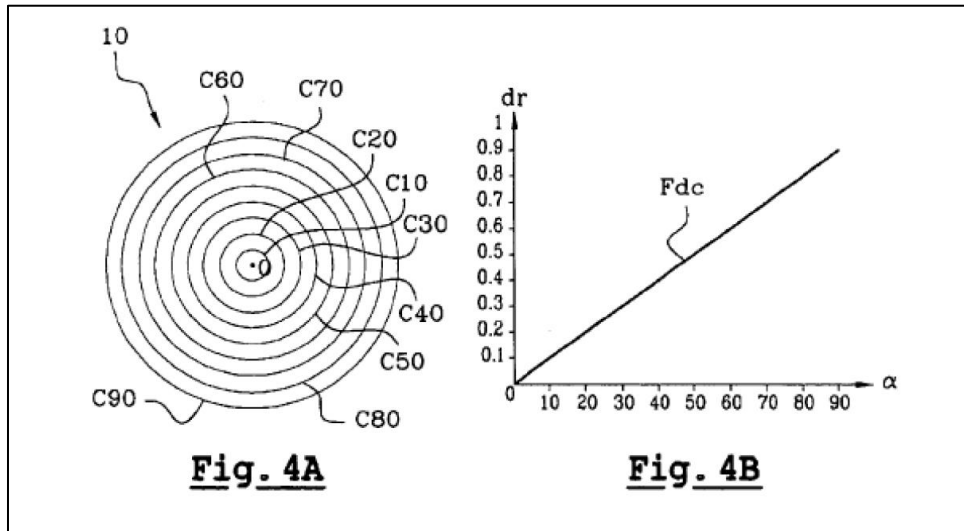
76. **Fifth**, Mr. Munro’s declaration also incorrectly asserted that “Baker makes no mention of utilizing the size of the image disk (in pixels, micrometers, or any other unit of measure) in the de-warping image processing algorithm.” EX-2001, ¶57. This is wrong. Baker specifically teaches use of edge detection to identify

edges of the image, which are used to detect the extent or size of the image. See, e.g., APPLE-1006, 15:54-59 (“One feature of the transform processors is the valid source address flag within the transform processor engine. This allows the user to construct abutting sub-images in the (x,y) plane without danger of edge interference. Thus, edge detection of the unused areas outside the circular image of FIG. 4 can alert the system to ignore these values.”), 16:13-15 (“Image filtering can be performed as well as edge detection in associated processes during the course of manipulation.”). In fact, even Mr. Munro confirmed during deposition that edge detection algorithms were known before May 2001 and would be used to determine extent of images, which he also separately confirmed, represent the radius of the image. APPLE-1025, 49:5-19, 16:5-15, 37:18-38:6.

B. Shiota’s Image Transformation Techniques are Commensurate to Those Disclosed by the ’990 Patent’s Specification

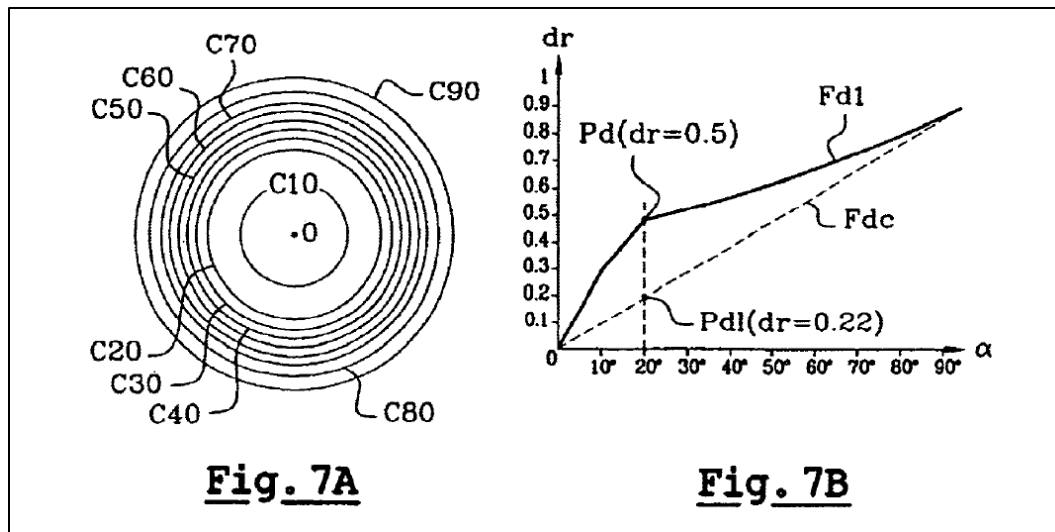
77. Like Shiota’s image transformation process, the ’990 Patent’s specification describes an image circle diameter/image disk with normalized image heights ranging from 0 to 1. For example, the ’990 patent’s specification states that: “FIG. 4B represents the shape of the distribution function F_{dc} of a classical panoramic objective lens, which determines the **relative distance dr** of an image point in relation to the center of the image disk according to the field angle α of the corresponding object point. The **relative distance dr is between 0 and 1** and is equal

to the *distance of the image point in relation to the center of the image divided by the radius of the image disk.*” APPLE-1001, 2:30-41 (emphasis added).



78. Moreover, Mr. Munro confirmed that the relative distance dr refers to a normalized measure of distance of image points in an image, with a maximum, normalized distance (image size) of 1 at the maximum field angle of 90 degrees (as represented by largest circle C90 in FIG. 4A above). EX-2001, ¶32; APPLE-1025, 16:16-19:13.

79. FIGS. 7A and 7B of the '990 Patent similarly show the same reference to the normalized distance of image points in the image (dr), with the maximum image size normalized to 1 for the corresponding field angle of 90 degrees (and represented using circle C90 in FIG. 7A below). APPLE-1001, FIG. 7; *see id.*, FIG. 9 and corresponding disclosures; APPLE-1025, 20:2-21:8.



80. Thus, the above embodiments in the '990 Patent's specification use an image distribution function, referred to as F_d , that uses a normalized image size of 1 and therefore, identifies relative or normalized distances of image points ranging from 0 to 1. See EX-2001, ¶¶36-37 (ImmerVision's expert acknowledged that (1) α - dr curve in the '990 patent represents the claimed non-linear distribution function and (2) dr represents a "relative distance," which is a "dimensionless" quantity that has values ranging from 0 to 1); APPLE-1025, 16:16-19:13, 20:2-21:8.

81. Similar to this disclosure in the '990 Patent's specification, and as explained above (see §VI.A *supra*), Shiota follows the conventional practice in the field of optics and optical design when it discloses the use of a non-linear image distribution function where the size of the image is normalized—i.e., has an "assumed" radius 1 of an image of an object positioned at the field angle of 90 degrees. APPLE-1012, [0023]; see APPLE-1003, ¶¶191-213.

82. Moreover, like the image transformation process of the Baker-Shiota combination, the '990 Patent similarly describes its correction technique as using a non-linear distribution function (where the function uses a normalized image size/radius of 1) and scales this value using the size L of the obtained image disk/circle. Specifically, as part of its description of the correction techniques, the '990 patent's specification states that "the image points $p(p_u, p_v)$ corresponding to the image points $E(i, j)$ of the display window DW are 'retrieved' from the image disk $ID1$, by means of the function F_d ." APPLE-1001, 13:25-30. The '990 specification further explains that function " F_d " refers to the "non-linear distribution function F_d according to the present invention"—which as described above—is an image distribution function, with a maximum image size normalized to 1. APPLE-1001, 13:9-13 ("The image points P thus determined are then projected onto the image disk $Imgl$ by means of the non-linear distribution function F_d according to the present invention"); see EX-2001, ¶¶32-37.

83. However, because the non-linear distribution function uses a normalized image size/radius of 1, simply multiplying the relative or normalized distance values for an image point with the corresponding image coordinates of that point would not retrieve the actual and corrected image points. APPLE-1025, 38:7-11 ("Q: Could the non-linear distortion be removed using only the non-linear

distribution function and not the size of the image? A: It would be incomplete. The answer really is no.”).

84. As a result, when the '990 specification describes the correction method using its image distribution function, F_d (e.g., multiplying image coordinates U and V with the image distribution function, $F_d(\alpha)$, it applies the actual image size L as a scale factor (in a multiplication operation) to retrieve the actual, corrected image points:

18/	$p_u = L * U * F_d(\alpha)$
19/	$p_v = L * V * F_d(\alpha)$

APPLE-1001, 14:10-35; *see id.*, 13:45-47 (stating that “ p_u and p_v are the Cartesian coordinates of an image point p of the image disk in the coordinate system $O'UV$,” and “ L is the size of the image disk, in number of pixels”); APPLE-1025, 39:1-7 (Mr. Munro testifying that “[b]ecause the [non-linear distribution] function is provided in relative terms, one would need to scale that using the image size to obtain” the “actual image point, that is corrected.”).

85. Mr. Munro also confirmed during deposition that the size L of the obtained image corresponds to the extent or edge of the image from the optical axis, which he further explained is the radius of the image. APPLE-1025, 16:5-15 (explaining that the radius of an image is the distance between the extent of the image (as produced by the lens) and the optical axis), 37:18-38:6 (testifying that quantity

L as described in the specification is the distance to the extent of the image produced by the lens from the optical axis).

86. Similarly, in view of Shiota's described image transformation operations as applied in combination with Baker and as explained above in §VI.A, Shiota's image distribution function uses a normalized image circle radius of 1, which a POSITA would have found obvious to scale using the actual image size to obtain the actual and corrected/transformed image points on the fisheye image. APPLE-1012, [0023]; APPLE-1003, ¶¶191-213; *see* APPLE-1025, 21:9-22:8, 23:6-24:10; APPLE-1026, pp. 53, 57, 199; APPLE-1027, p. 320.

87. As explained above (*see* §VI.A *supra*), Shiota teaches that (1) the ***“image circle diameter differs according to the size of the image pickup device and the focal distance of the fisheye lens,”*** (2) while a normalized image radius of 1 is used, “magnification adjustment is performed” in “actual[] use, and (3) as part of its image transformation, “projection coordinates” or image points on the “image pickup face are obtained” *Id.*, [0023]-[0024], [0036]-[0042]; *see* above analysis for §VI.A; APPLE-1003, ¶¶191-213.

88. Given these disclosures, a POSITA would have found obvious that the image transformation described in Shiota, when applied to an actual application, would retrieve the image points on the actual image circle/disk—and not on the normalized image circle/disk. And, thus, to retrieve the corrected/transformed

image points that are projected on an actual image disk/circle, a POSITA would have found obvious that the image points obtained via the image distribution that uses a normalized image radius/size of 1, would be scaled—*i.e.*, “magnification adjustment” would be performed—using the actual image size/radius (as measured in pixels). APPLE-1003, ¶¶205-213; *see also* APPLE-1025, 27:15-19, 49:5-50:14 (confirming that image size/radius would be known to a designer as part of the optical design process; further testifying that conventional edge detection algorithms from the May 2001 timeframe could be used to detect extent or radius of the image).

89. The above can also be expressed simply in mathematical terms. An image distribution function, when normalized to have a radius/size of 1, represents a relationship between a relative image height (ranging from 0 to 1) and field angles (ranging from 0 to 90 degrees). *See also* EX-1025, 20:2-21:8, 16:16-17:4 (testifying that “relative distance is like a percentage” and represents a “normalized distance value”). The relative image height or distance of a particular point represents a radial distance or height of a particular point in the image plane divided by the radius of the image. Such a normalized distribution function therefore identifies a relative radial distance of a point in the image plane at a particular field angle (α):

$$(\textit{relative radial image}) = \frac{ (\textit{radial distance}) }{ (\textit{image radius}) } = Fd(\alpha)$$

See APPLE-1025, 14:14-17:16.

90. It follows then that to obtain the actual radial distance of that image point would simply involve multiplying the relative radial distance by the actual radial distance.

$$(Image\ radius) * (relative\ radial\ distance) = (radial\ distance)$$

91. In summary, when Shiota's techniques, as applied in combination with Baker and applied in an actual use/implementation, a POSITA would have found obvious to scale the obtained image points using the normalized distribution function (where the image heights are normalized using an image size of 1) with the actual image size/radius (e.g., as measured in pixels)—and thereby retrieve the actual, corrected/transformed image points as projected on an actual image circle/disk.

92. For the above reasons and the additional reason described in my first declaration, it is my opinion that the combination of Baker and Shiota renders obvious claim 27, including the limitation of correcting the non-linearity of the obtained image using the non-linear image distribution function and the size L of the obtained image—in a manner commensurate with how such correction is described as being performed in the '990 Patent's specification.

93. Therefore, it is my opinion that the combination of Baker and Shiota renders claim 27 obvious.

VII. CLAIM 2, 4, 29, AND 30 ARE RENDERED OBVIOUS BY THE PRESENTED BAKER-SHIOTA AND BAKER-SHIOTA-FISHER COMBINATIONS

94. In my original declaration, I explained that claims 2, 4, and 29, which depend from claim 27, are rendered obvious by the Baker-Shiota combination. APPLE-1003, ¶¶214-240. I also explained that claims 29 and 30, which depend from claim 27, are rendered obvious by the Baker-Shiota-Fisher combination. APPLE-1003, ¶¶241-259.

95. Other than reiterating and referring back to their arguments presented with respect to claim 27, ImmerVision and Mr. Munro do not offer any additional rebuttal with respect to my analysis for the specific additional limitations recited in these dependent claims. See POR, 20-21; EX-2001, ¶¶59-60. As explained above, the Baker-Shiota combination renders claim 27 obvious (and that too in a manner commensurate with how the claimed functionality is described in the '990 specification) and ImmerVision and its expert's rebuttals rest on flawed and incomplete characterizations of my testimony. See §VI.A-B *supra*.

96. For these reasons and for the reasons described in my original declaration, it is my opinion that claims 2, 4, 29, and 30 are rendered obvious by the presented Baker-Shiota and Baker-Shiota-Fisher combinations.

VIII. ADDITIONAL REMARKS

I currently hold the opinions expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

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



Dated: 1/16/2024

By: David Kessler, Ph.D.