

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

IMMERVISION, INC.,
Patent Owner.

Case IPR2023-00471
Patent 6,844,990

**PETITIONER'S REPLY TO
PATENT OWNER'S RESPONSE**

TABLE OF CONTENTS

I.	Claim 27 is Rendered Obvious by the Presented Combination of Baker and Shiota	1
A.	The Petition and Dr. Kessler’s Testimony—When Considered in Their Proper Context—Demonstrate that Shiota’s Teachings as Applied in Combination with Baker Render Obvious Limitation [27f].....	3
B.	ImmerVision’s Rebuttals are Premised on Mischaracterizations of the Record	7
C.	ImmerVision’s Attempts to Distinguish Shiota Fail Because Shiota’s Image Transformation Techniques are Commensurate to Those Disclosed by the ’990 Patent’s Specification	14
II.	Claim 2, 4, 29, and 30 Are Rendered Obvious by the Presented Baker-Shiota and Baker-Shiota-Fisher Combinations	23
III.	Conclusion	24

PETITIONER’S EXHIBIT LIST

APPLE-1001	U.S. Patent No. 6,844,990 to Artonne et al. (“the ’990 patent”)
APPLE-1002	Prosecution History of the ’990 Patent (“Original Prosecution History”)
APPLE-1003	Declaration of Dr. David Kessler, Ph.D.
APPLE-1004	Curriculum Vitae of Dr. David Kessler, Ph.D.
APPLE-1005	Service of complaint in <i>ImmerVision, Inc. v. Apple, Inc.</i> , D.Del. 1:21-cv-01733-MN-CJB (January 18, 2022)
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-1008	Service of complaint in <i>ImmerVision, Inc. v. Apple, Inc.</i> , D.Del. 1:21-cv-01484-MN-CJB (January 18, 2022)
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 for the ’990 Patent (“Reexam History”)
APPLE-1012	EP 1028389 A2 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”) (original and translated documents also provided in APPLE-1011, 43-51, 180-198, as provided by Patent Owner during reexamination)

APPLE-1015	U.S. Patent No. 5,861,999 to Tada (“Tada”)
APPLE-1016	Zeljko Andreic, “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-1019	Petition for Inter Partes Review of U.S. Patent No. 6,844,990, filed by Panasonic System Networks Co., Ltd. (IPR2014-01438)
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-1021	Vidal, “Interim Procedure for Discretionary Denials in AIA Post Grant Proceedings with Parallel District Court Litigation” (USPTO, June 2021)
APPLE-1022	Scheduling Order entered in <i>ImmerVision, Inc. v. Apple, Inc.</i> , D.Del. 1:21-cv-01733-MN-CJB and <i>ImmerVision, Inc. v. Apple, Inc.</i> , D.Del. 1:21-cv-01484-MN-CJB (entered on June 21, 2022)
APPLE-1023	Second Declaration of Dr. David Kessler, Ph.D.
APPLE-1024	U.S. Patent No. 4,364,643 to Momiyama (“Momiyama”)
APPLE-1025	Deposition Testimony of Mr. James F. Munro
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)

Petitioner Apple Inc. (“Apple” or “Petitioner”) submits this Petitioner Reply (“Reply”) to ImmerVision’s Patent Owner Response (“POR”) to the IPR Petition (“Petition”) of U.S. Patent 6,844,990 (“’990 Patent”), which challenges independent claim 27 and claims 2, 4, 29, and 30 that depend from claim 27 (collectively, the “Challenged Claims”).

I. CLAIM 27 IS RENDERED OBVIOUS BY THE PRESENTED COMBINATION OF BAKER AND SHIOTA

ImmerVision does not dispute that a POSITA would have combined the Baker and Shiota references, nor does it dispute that the resulting combination of Baker and Shiota would have rendered obvious claim elements [27pre] to [27e]. *See generally* POR. 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.

To demonstrate obviousness of this limitation, the Petition and the supporting expert testimony of Dr. Kessler leveraged teachings of the Shiota reference as applied in combination with the teachings of the Baker reference. *See* Petition, 45-55, 22-27; APPLE-1003, ¶¶191-213, 128-139, 105-121. ImmerVision and its expert

(Mr. Munro) assert that Petitioner has failed to demonstrate that the Baker-Shiota combination would render this claim feature obvious. POR, 1-2, 14-19; EX-2001, ¶¶49-58. However, in advancing their rebuttals, ImmerVision and its expert mischaracterize the Petition by omitting key portions of the Petition’s analysis and the corresponding testimony of Dr. Kessler, as well as the cited disclosures of the Shiota reference, as applied in combination with Baker. *See* APPLE-1023, ¶¶50-76.

As explained below, Patent Owner’s arguments incorrectly characterize Dr. Kessler’s 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, however, omits the surrounding context of that paragraph in Shiota as relied upon by Dr. Kessler—namely, Shiota’s teachings of variations in image size with image sensor size, using a normalized image size of 1 for its distribution function, and performing magnification adjustment to the image in actual use—and how those 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. *Id.* Moreover, ImmerVision’s incomplete narrative also omits that Shiota’s teachings (as leveraged in combination with Baker) are commensurate with how the ’990 Patent’s specification describes performing the correction of non-linearity of the image using the non-linear distribution function and size L of the image, as recited in claim 27. APPLE-1023, ¶¶77-93.

A. The Petition and Dr. Kessler’s Testimony—When Considered in Their Proper Context—Demonstrate that Shiota’s Teachings as Applied in Combination with Baker Render Obvious Limitation [27f]

The Petition, citing Dr. Kessler’s testimony, explained that the Baker-Shiota combination would have rendered obvious limitation [27f], which recites correcting the non-linearity of the image 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. Petition, 22-27, 45-55; APPLE-1003, ¶¶191-213.

Specifically, and as explained in the Petition and Dr. Kessler’s supporting testimony, the Baker-Shiota combination would have leveraged Shiota’s teachings describing image correction by applying a correction coefficient (k_2)—which is determined based on a non-linear image distribution function—to the captured image, to obtain transformed image points that compensate for the distortion in the captured image. *See* Petition, 48-49; APPLE-1012, [0022]-[0024], [0037]-[0042]; APPLE-1003, ¶¶116-121, 128-138, 191-213. Specifically, Dr. Kessler explained that Shiota determines this correction coefficient, k_2 , using the following equation: $k_2 = h/r$, where (1) h represents the height of an image point from the origin, expressed using a non-linear image distribution function and (2) r is the distance from the origin of an X, Y, Z coordinate system to the projected point on the image

plane. APPLE-1003, ¶¶116-121, 128-138, 201-202; APPLE-1012, [0037]-[0042], [0036] (explaining that height (h) from the origin on the fisheye image face (origin of the p, q coordinate system) to an image point w is expressed as a function of the field angle and the focal distance).

The Petition further explained that the Baker-Shiota combination would have also leveraged Shiota's teachings to render obvious "using the size of the image" as part of Shiota's described image transformation/correction:

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.

Petition, 50-51; APPLE-1003, ¶205. The cited portion of Shiota is reproduced below (APPLE-1012, [0023] (annotated)):

[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.

Given these disclosures in Shiota and in view of the above analysis, Dr. Kessler opined that “these references to ‘magnification adjustment’ and variation in image size based on size of the image disk/sensor refer to an adjustment that accounts for the actual size of the image pickup device—and by extension, the actual size of the image—as part of the image transformation.” APPLE-1003, ¶205. Dr. Kessler further opined that “a POSITA would have understood or found obvious that the image transformation described in Shiota, when applied to an actual application[,], accounts for the size of the actual image for the underlying image transformation.” APPLE-1003, ¶206.

Because the size of the image pickup device (and by extension the size of the image) varies depending on the implementation (as Shiota expressly teaches), Dr.

Kessler explained that “a POSITA would have found it obvious to use the actual size of the image—as applicable in Baker’s system—as part of the image transformation to generate a properly compensated/transformed image for display.” APPLE-1003, ¶¶205-206; APPLE-1012, [0023]. Dr. Kessler further explained that a POSITA would have understood or found obvious that the size of the image would be represented using any appropriate units, e.g., pixels, inches, millimeters, etc. APPLE-1003, ¶¶207-213 (citing APPLE-1006, 14:64-15:19; APPLE-1012, [0022]-[0023], [0025], [0049]).

In this manner, the Petition in view of Dr. Kessler’s supporting testimony demonstrated that the Baker-Shiota combination would have rendered obvious the claim features reciting “correcting the non-linearity of the image by retrieving image points on the obtained image ... using at least the non-linear distribution function and a size L of the obtained image,” where the size L of the obtained image would be expressed in units of pixel or another appropriate unit. *See* Petition, 45-55; APPLE-1003, ¶¶191-213.

B. ImmerVision's Rebuttals are Premised on Mischaracterizations of the Record

As explained below, ImmerVision advances multiple rebuttal arguments, each of which is premised on mischaracterizations of the Petition, Dr. Kessler's testimony, and the express teachings of Shiota. APPLE-1023, ¶¶50-76.

First, ImmerVision characterizes Dr. Kessler as relying on Shiota's disclosures of—"the radius of the fisheye image [being] set to 1" and that "[a]t the time of actually (sic) use, magnification adjustment is performed"—and "conclusorily leap[ing]" from these teachings to the "assumption" that Shiota's described "magnification adjustment" is "an adjustment that accounts for the actual size of the image." POR, 15-16; *see id.* (similarly alleging 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").

This mischaracterizes Dr. Kessler's testimony because it omits key portions of Shiota's cited disclosures that formed the predicate for his testimony. APPLE-1023, ¶¶50-51. The cited testimony (which is reproduced above and excerpted in part below) confirms that Dr. Kessler was not limiting his discussion to just Shiota's reference to "magnification adjustment." *Id.* Rather, Dr. Kessler's testimony relied upon Shiota's teachings that: (1) the image circle diameter varies 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 in “actual[] use” as part of Shiota’s image transformation operations that retrieve the corrected image points (*id.*):

Dr. Kessler’s Testimony (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.

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

¹ Emphasis added unless otherwise noted.

retrieving image points and correcting image distortion.” POR, 16; *see* EX-2001, ¶¶50-52. This argument again rests on the faulty premise that Dr. Kessler’s analysis for this claim feature is exclusively limited to Shiota’s reference to “magnification adjustment.” APPLE-1023, ¶52.

Moreover, ImmerVision fails to give proper weight and consideration to the entirety of Dr. Kessler’s testimony for this limitation. Indeed, when considered in its proper context, Dr. Kessler’s testimony demonstrated 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 the corrected image points for display. *See* APPLE-1023, ¶¶52-63.

Specifically, as Dr. Kessler 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; APPLE-1023, ¶¶53-54 (explaining that the height also refers to radial distance or image height, and that angle θ relates to the field angle). 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; APPLE-1023, ¶¶55-56 (explaining that h, or image height at the extent of the image, occurs at the field angle of 90 degrees and constitutes the

image radius). 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. EX-1003, ¶¶205-206; APPLE-1023, ¶¶55-56 (because image height or distance is computed using a function that uses a normalized image size of 1, the image height/distance in Shiota would be provided in relative terms, on a scale ranging from 0 to 1); APPLE-1025, 23:14-21, 15:5-17:8, 37:18-38:6; APPLE-1012, [0023].

Notably, such normalization of image parameters (e.g., image size and focal length) to a normalized value (e.g., 1) was well known and common in optics. APPLE-1023, ¶¶56-58 (citing APPLE-1024, FIGS. 1-6, 2:6-8; APPLE-1009, FIGS. 3 and 4 (showing "normalized image height" ranging from 0 to 1); APPLE-1026, 53, 199 (showing full field/image size normalized to 1 while acknowledging the actual image height of obtained image (referenced as GIH or gaussian image height) is 52.94 mm); APPLE-1027, p. 320 (normalizing image size and focal length to 1)); APPLE-1025, 21:9-22:8, 23:6-24:10, 16:16-18:3 (Patent Owner's expert confirming the same), 18:8-19:13. Indeed, Patent Owner's expert confirmed that normalizing the image size to 1 was "commonly done throughout the field of optics and lens design" 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.

While the image heights are normalized on a scale of 0 to 1 to make the math “independent of actual image size,” Patent Owner’s expert further confirmed that, “when you are considering an actual application, then you would have to scale up to account for the actual image size.” APPLE-1025, 21:9-22:8, 23:14-24:10; *see also id.*, 25:19-26-21, 39:1-18; APPLE-1023, ¶¶59-60; *see* APPLE-1026, pp. 53, 57; *see also* APPLE-1027, p. 320. 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. EX-1003, ¶¶191-213; EX-1023, ¶¶59-60.

Specifically, Dr. Kessler testified that Shiota uses the non-linear distribution function in computing its correction parameter (k_2) that is used to obtain corrected image points for display. APPLE-1003, ¶202 (citing APPLE-1012, ¶¶[0022]-[0024], [0037]-[0042]). And, while the heights of the image points obtained using this distribution function are normalized values (given that the function applies a normalized image size/radius 1), Shiota also recognizes that, as part of its image transformation, “projection coordinates” or image points on the “image pickup face

are obtained” APPLE-1023, ¶61; APPLE-1012, [0023], [0036]-[0042]; APPLE-1003, ¶¶199-213; *see* APPLE-1025, 29:22-30:4, 29:22-30:4. 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. APPLE-1003, ¶¶205-206; APPLE-1023, ¶61. Indeed, Shiota acknowledges this 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-1023, ¶62; APPLE-1012, [0023]; APPLE-1003, ¶¶205-206.

As a consequence, while 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.” APPLE-1012, [0023]; APPLE-1023, ¶¶61-63, 55-60; APPLE-1003, ¶¶191-213; *see also* APPLE-1003, ¶¶205-206; APPLE-1025, 23:6-24:10. Thus, given Shiota’s express teaching that size of the image pickup device (and by extension size of the image) varies depending on the implementation, and because Shiota’s image transformation is illustrated using a normalized image size of 1, “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 (as obtained on the actual image sensor/pickup device) for display. *Id.*

Third, ImmerVision and its expert characterize Dr. Kessler as “link[ing]” certain operator selected parameters described in paragraphs 24 to 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. Dr. Kessler 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 Dr. Kessler’s testimony for the present limitation (limitation [27f]). *See* APPLE-1003, ¶¶191-213; *see also id.*, ¶151 (similarly citing Shiota’s paragraphs 22-26 as well as 37-42 to reference its image transformation process); APPLE-1023, ¶¶64-65.

Moreover, ImmerVision and its expert concede that these allegedly operator-selected parameters in paragraphs 24 and 26 of Shiota relate to the “plane image” referenced in Shiota (expressed in u,v coordinates) (*see* POR, 17-19; Ex. 2001, ¶¶54-57)—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]; APPLE-1023, ¶66. And, paragraph 23 of Shiota and Dr. Kessler’s opinions with respect to the same, confirm that the Shiota’s references to the “image circle diameter,” the normalized/assumed radius of 1, and the “magnification adjustment” due to “the image circle diameter differ[ing] according to the size of the image

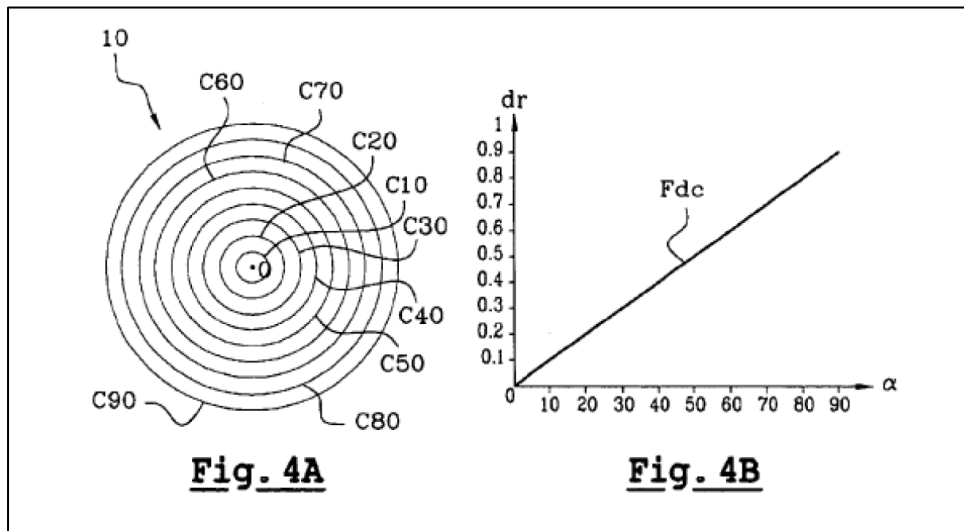
pickup device—all relate to the fisheye image obtained on the image pickup device (which corresponds to the “obtained image” on the “image sensor,” as recited in claim 27). APPLE-1003, ¶¶205-206; *see id.*, APPLE-1012, [0023]-[0024]; APPLE-1023, ¶67.

C. ImmerVision’s Attempts to Distinguish Shiota Fail Because Shiota’s Image Transformation Techniques are Commensurate to Those Disclosed by the ’990 Patent’s Specification

ImmerVision’s attempts to avoid Shiota’s disclosures ring hollow when considering that the image correction techniques described in the ’990 Patent’s specification that relate to the claimed functionality at issue in limitation [27f], are commensurate with Shiota’s teachings (as applied in combination with Baker). APPLE-1023, ¶¶77-93.

As a starting point, like Shiota’s image transformation process, the ’990 Patent’s specification describes an image circle diameter/image disk with a 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*

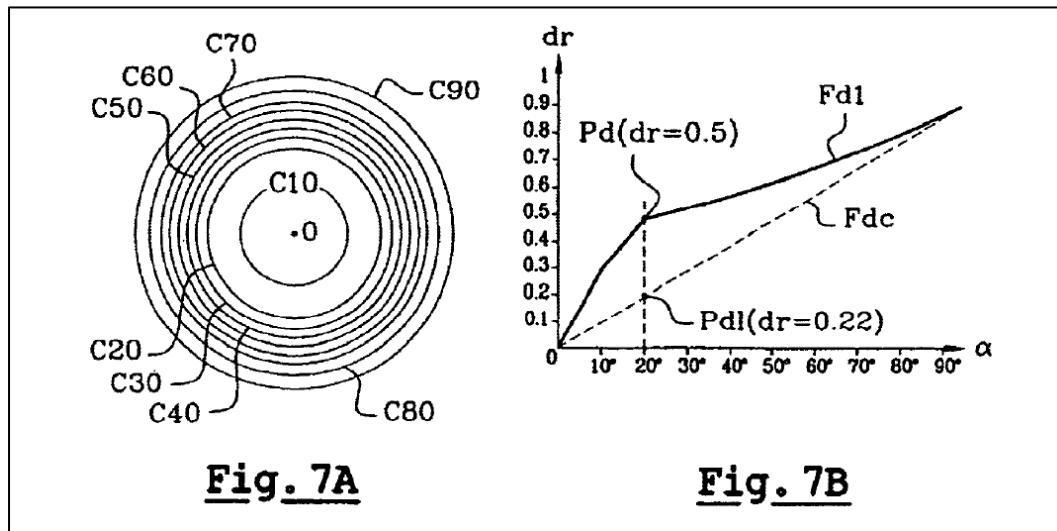
image divided by the radius of the image disk.” APPLE-1001, 2:30-41 (emphasis added); APPLE-1023, ¶¶77-78.



Moreover, Patent Owner's expert confirmed that the relative distance dr refers to a normalized measure of distance of image points in an image, with a maximum, normalized distance (i.e., the 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, 16:6-19:13 (confirming the same and further testifying that (1) relative distance is “like a percentage” or “normalized distance value” ranging from 0 to 1 and (2) noting that relative distance and relative image height are equivalent in field of optics), 14:4-16:4.

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 (and corresponding disclosure); *see id.*, FIG. 9 and corresponding disclosures; APPLE-1025, 20:2-21:8; APPLE-1023, ¶79.



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. APPLE-1023, ¶¶77-80; *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.

Similar to this disclosure in the '990 Patent's specification, and as explained above (*see* §§I.A-B *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]; APPLE-1023, ¶¶81, 55-60.

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. APPLE-1023, ¶¶82-85; APPLE-1025, 26:22-30:4. 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-1023, ¶82; APPLE-1001, 13:9-13 (“The image points P thus determined are then projected onto the image disk $Img1$ by means of the non-linear distribution function F_d according to the present invention”); *see* EX-2001, ¶¶36-37.

However, given that 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-1023, ¶83; 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.”); *see also id.*, 30:5-31:8, 32:1-4, 35:10-36:18. As a result, when the '990 specification describes the correction method using its image distribution function, F_d that is provided in relative term, it applies the actual image size L as a scale factor to retrieve the actual, corrected image points (e.g., multiplying the size L with the product of image coordinates U and V and image distribution function, $F_d(\alpha)$):

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 (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.”); APPLE-1023, ¶¶84-85 (explaining that size L of the image is multiplied with the non-linear distribution function F_d).

Relatedly, ImmerVision’s expert testified that the size L of the obtained image—as used in the ’990 Patent’s specification—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 of the extent of the image (as produced by the lens) from the optical axis), 37:15-38:6 (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), 39:1-7.

Similarly, in view of Shiota’s described image transformation operations as applied in combination with Baker and as explained above (*see* §§I.A-B *supra*), Shiota’s image distribution function uses a normalized 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, ¶¶205-206; APPLE-1023, ¶¶86-92; *see* APPLE-1025, 21:9-22:8, 23:6-24:10; APPLE-1026, pp. 53, 57, 199; APPLE-1027, p. 320. As explained above, 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”

on the “image pickup face are obtained” *Id.*, [0023]-[0024], [0036]-[0042]; APPLE-1023, ¶¶86-87, 54-63; APPLE-1003, ¶¶191-213.

In view of 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. APPLE-1023, ¶88. 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 non-linear image distribution function 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-1023, ¶¶88-92; APPLE-1003, ¶205-213²; *see also* APPLE-1025, 27:15-19, 49:5-50:14 (confirming that

² 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, 16; EX-2001, ¶58. This assertion is refuted by Shiota, which expressly teaches that the image circle diameter differs according to the size of the image pickup device/sensor. APPLE-1012, [0023]; APPLE-1023, ¶68. Thus, image size and sensor size are in fact directly related. APPLE-1023, ¶¶68-69. That the image size may not be exactly the same

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); APPLE-1023, ¶¶76, 88-91 (citing APPLE-1006, 15:54-59, 16:13-15 (explaining that use of edge detection to detect edges, which represent the extent or radius of the image, was well known and even Baker disclosed this as part of its image transformation descriptions)); APPLE-1025, 25:19-26:14, 39:1-18, 49:5-50:14.

In summary, when Shiota's techniques—as applied in combination with Baker—are used in an actual use/implementation, a POSITA would have found

as the size of the sensor is beside the point—and indeed, Dr. Kessler did not posit such equality between sensor size and image size. *See id.*; APPLE-1003, ¶¶205-206. Nevertheless, a POSITA would have recognized that there are multiple applications in which the image size and the sensor size are directly related—as confirmed by the reference identified by ImmerVision's own expert which shows the image circle diameter having the same size as the diagonal of the image sensor. *See* EX-2005, FIG. 11, ¶106; APPLE-1023, ¶¶70-72; *see* APPLE-1023, ¶¶73-75 (also explaining that Mr. Munro's reference to sensor underfilling based on Fig. 2 is refuted by his deposition testimony regarding the same); APPLE-1025, 45:22-47:18; 43:14-45:21; *see also id.*, 43:14-45:21, 41:10-42:16.

obvious to scale obtained image points as obtained 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. EX-1023, ¶¶87-93.

On the present record, Petitioner has adequately demonstrated that the combination of Baker and Shiota renders obvious “correcting the non-linearity of the initial image ... by retrieving image points on the obtained image ... using at least the non-linear distribution function and a 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. ImmerVision’s arguments to the contrary should be rejected because they are premised on incomplete and incorrect characterizations of the Shiota reference as well as the arguments and analysis advanced in the Petition and the supporting testimony of Dr. Kessler. *Id.*

For the above reasons and for the additional reasons described in the Petition and the corresponding declaration of Dr. Kessler, Petitioner has demonstrated that the combination of Baker and Shiota renders claim 27 obvious.

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

The Petition, in view of the supporting testimony of Dr. Kessler, demonstrated that claims 2, 4, and 29, which depend from claim 27, are rendered obvious by the Baker-Shiota combination. Petition, 55-62. The Petition, in view of the supporting testimony of Dr. Kessler, also demonstrated that claims 29 and 30, which depend from claim 27, are rendered obvious by the Baker-Shiota-Fisher combination. Petition, 62-70.

Other than reiterating and referring back to its arguments presented with respect to claim 27, ImmerVision does not offer any additional rebuttal with respect to the Petition's analysis presented for the specific additional limitations recited in these dependent claims. *See* POR, 20-21. As explained above, ImmerVision's arguments with respect to claim 27 are flawed, and lack merit given that the presented combination operates in a manner similar to the described embodiments in the '990 Patent's specification. *See* §I.B-C *supra*. On this record, Petitioner submits that the Petition (and the supporting evidence and testimony) adequately demonstrate that claims 2, 4, 29, and 30 are rendered obvious by the presented Baker-Shiota and Baker-Shiota-Fisher. APPLE-1023, ¶¶94-96.

III. CONCLUSION

For the foregoing reasons, Petitioner respectfully requests that the Board issue a Final Written Decision finding the Challenged Claims unpatentable.

Respectfully submitted,

Date: January 16, 2024

/Karan Jhurani/

W. Karl Renner, Reg. No. 41,265

David Holt, Reg. No. 65,161

Karan Jhurani, Reg. No. 71,777

Fish & Richardson P.C.

60 South Sixth Street

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

Attorneys for Petitioner

CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petitioner Reply to Patent Owner Response totals 4,683 words, which is less than the 5,600 allowed under 37 CFR § 42.24(c)(1).

Respectfully submitted,

Date: January 16, 2024

/Karan Jhurani/

W. Karl Renner, Reg. No. 41,265

David Holt, Reg. No. 65,161

Karan Jhurani, Reg. No. 71,777

Fish & Richardson P.C.

60 South Sixth Street

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

Attorneys for Petitioner

CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4) and 42.205(b), the undersigned certifies that on January 16, 2024, a complete and entire copy of this Petitioner's Reply to Patent Owner's Response and accompanying exhibits were provided by email to the Patent Owner by serving the correspondence address of record as follows:

Stephen E. Murray, smurray@panitchlaw.com
Keith A. Jones, kjones@panitchlaw.com
PANITCH SCHWARZE BELISARIO & NADEL LLP
Two Commerce Square
2001 Market Street, Suite 2800
Philadelphia, PA 19103

John D. Simmons, jsimmons@panitchlaw.com
Dennis J. Butler, dbutler@panitchlaw.com
PANITCH SCHWARZE BELISARIO & NADEL LLP
Wells Fargo Tower
2200 Concord Pike, Suite 201
Wilmington, DE 19803

/Crena Pacheco/
Crena Pacheco
Fish & Richardson P.C.
60 South Sixth Street, Suite 3200
Minneapolis, MN 55402
pacheco@fr.com