

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ARASHI VISION (U.S.) LLC (D/B/A INSTA360)
Petitioner,

v.

GOPRO, INC.
Patent Owner.

Patent No. 10,529,052

Inter Partes Review No. IPR2025-00017

**PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.100 *et seq.***

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I. INTRODUCTION

Petitioner Arashi Vision (U.S.) LLC (d/b/a Insta360) (“Petitioner”) petitions for *inter partes* review of claims 1-20 of U.S. Patent No. 10,529,052 (“the ’052 patent” (EX1001)). The challenged claims do not present any patentable improvement over the prior art, as set forth in the Petition and in the supporting Declaration of Dr. Aggelos Katsaggelos. (EX1002.) Accordingly, Petitioner requests that the Board institute *inter partes* review of the ’052 patent and cancel the challenged claims at the conclusion of the instituted proceeding.

II. THE ’052 PATENT

A. Summary

The ’052 patent is directed to simulating image distortion of a virtual lens. As the ’052 patent explains, it can be desirable to perform crop or zoom operations on an image to extract reduced field-of-view sub-frames. (EX1001, 1:14-16; EX1002, ¶9.) It is further desirable for the sub-frames to have lens characteristics that are consistent with the lens characteristics “naturally appearing” in the original image. (EX1001, 3:13-32; EX1002, ¶9.) The ’052 patent describes applying a virtual lens model to the sub-frames in order to generate a “cohesive output video,” in which post-capture processing effects are “not apparent to the viewer.” (EX1001, 3:13-43; EX1002, ¶9.)

B. Effective Filing Date

The application that became the '052 patent is a continuation that was filed on August 8, 2019, and claims priority to a provisional application filed on May 20, 2015. (EX1001.) For purposes of this Petition, Petitioner relies on May 20, 2015 as the earliest effective filing date. (EX1002, ¶10.)

C. Prosecution History

The prosecution of the '052 patent was not robust. The claims did not face any statutory prior art rejections, and were allowed as originally filed without amendment. (EX1003.) The claims were allowed following only a single Office Action, which rejected the claims for non-statutory double patenting over the parent patents, but indicated that the claims were otherwise allowable as originally filed. (EX1003, 271-287; EX1002, ¶11.) The applicant overcame this rejection, and obtained an allowance of the original claims, by simply filing a terminal disclaimer over the parent patents. (EX1003, 25-29, 39, 42-44, 46-55; EX1002, ¶11.)

D. Level of Ordinary Skill in the Art

Based on the disclosure of the '052 patent and a priority date of May 20, 2015, a person of ordinary skill in the art (POSITA) in the field of the '052 patent would have had a bachelor's degree in Electrical Engineering, Computer Science, Physics, Optics, or an equivalent field, and one to two years of academic or

industry experience working on image or video processing, or comparable academic or industry experience. (EX1002, ¶18.)

III. CLAIM CONSTRUCTION

For purposes of this Petition, Petitioner does not believe any terms require a formal construction.¹ Each of the terms carries its “ordinary and customary meaning,” which is “the meaning that the term would have to a person of ordinary skill in the art in question” at the time of the invention.² *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007) (internal citation omitted); EX1002, ¶21.)

The '052 patent is the subject of co-pending ITC litigation as identified in Section VII. Patent Owner asserts that Petitioner infringes claims 1 through 10 of

¹ Petitioner interprets the challenged claims based on the breadth of GoPro’s infringement allegations in the related International Trade Commission (ITC) proceeding. (*See* EX1011.) Petitioner reserves the right to argue in the ITC proceeding that GoPro’s construction of the terms are incorrect and/or not supported by the '052 patent specification.

² An IPR petition may only rely on prior art patents or printed publications. 35 U.S.C. § 311(b). Petitioner reserves the right to raise other invalidity issues, such as invalidity under § 101 or § 112, in the related ITC proceeding.

the '052 patent. On August 16, 2024 and September 5, 2024, the parties exchanged proposed claim constructions for the '052 patent in the ITC proceeding as follows:

Term	Claim	Insta360's Proposed Construction	GoPro's Proposed Construction
the desired lens distortion and the input lens distortion exhibiting consistent lens characteristics	1	Indefinite If not indefinite: the desired lens distortion and the input lens distortion exhibiting distortion characteristics of the lens of the camera	Plain and ordinary meaning; no construction necessary
portions of the scene depicted in the subframes appear to have been captured using the reduced fields of view	1	Indefinite If not indefinite: portions of the scene depicted in the subframes appear to have been captured by the lens of the camera using the reduced fields of view	Plain and ordinary meaning; no construction necessary
wherein image stabilization is applied to the input images	2	wherein image stabilization is applied to the input images before generating output images	Plain and ordinary meaning; no construction necessary

Term	Claim	Insta360's Proposed Construction	GoPro's Proposed Construction
consistent frame-to-frame lens characteristics	7	Indefinite	Plain and ordinary meaning; no construction necessary

Petitioner does not believe any claim construction is necessary for this Petition, as the challenged claims are invalid under any reasonable interpretation. (EX1002, ¶¶22-23.) Moreover, the challenged claims are invalid under any or all of the claim construction positions taken by the parties in the ITC proceeding. (EX1002, ¶23.)

IV. PRECISE REASONS FOR RELIEF REQUESTED

Pursuant to 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq.* (including § 42.104(b)), Petitioner requests cancellation of claims 1-20 of the '052 patent based on the following references and the accompanying Declaration of Dr. Aggelos Katsaggelos (EX1002):

Prior Art Reference	Abbreviation (Exhibit No.)
U.S. Pub No. 2006/0017817 A1	Okubo (EX1004)
U.S. Patent No. 8,994,838 B2	Sokeila (EX1005)

Prior Art Reference	Abbreviation (Exhibit No.)
U.S. Patent No. 9,238,434 B2	Eder (EX1009)

The statutory grounds for the challenge of each claim are set forth below.

All statutory citations herein are AIA.

Ground	35 U.S.C. §	Claims	Prior Art Reference(s)
1	103	1-20	Okubo
2	103	1-20	Okubo, Sokeila
3	103	1-20	Eder

Below, Petitioner discusses why the challenged claims are unpatentable under the statutory grounds raised, including by specifying how and where the prior art satisfies each element of each challenged claim, as required by 37 C.F.R. § 42.104(b)(4)³. Petitioner's showing establishes that there is a reasonable likelihood that it will prevail on each ground of unpatentability to each challenged claim.

A. Ground 1: Claims 1-20 Are Obvious In View of Okubo

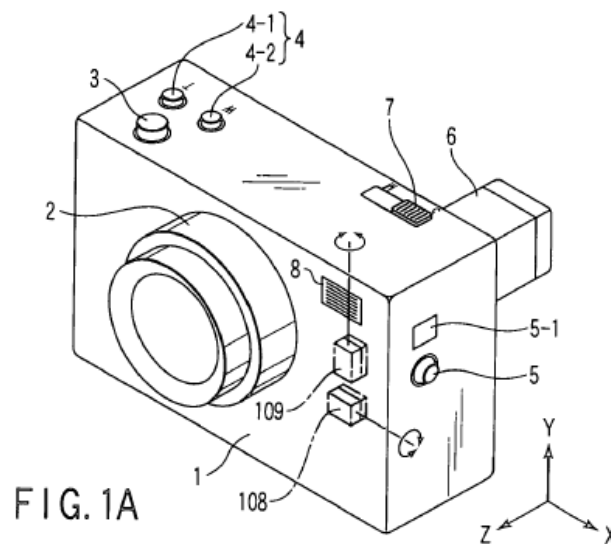
1. Summary of Okubo

Okubo is a U.S. Patent Application that was filed on July 18, 2005, and

³ Petitioner also shows how each claim preamble is satisfied, but does not concede that any preamble is limiting for any ground in the Petition.

published on January 26, 2006. (EX1004.) Okubo is thus prior art to the '052 patent under at least 35 U.S.C. §§ 102(a)(1) and (a)(2). Okubo was not cited or considered during prosecution of the '052 patent. (EX1003.)

Okubo discloses a “image pick-up apparatus,” which can be a digital video camera, that includes a lens unit 2 within a camera body 1. (EX1004, [0003], [0005], [0067], FIG. 1A; EX1002, ¶30.) FIG. 1A illustrates:



(EX1004, [0003], [0005], [0067], FIG. 1A; EX1002, ¶30.)

In the camera, as shown in FIG. 2, an image pick-up device 114, such as a charge-coupled device (CCD), is positioned behind the lenses 12, 13, 14 of the lens unit 2 such that light passing through the lenses forms an image on the CCD 114 and is photoelectrically converted:

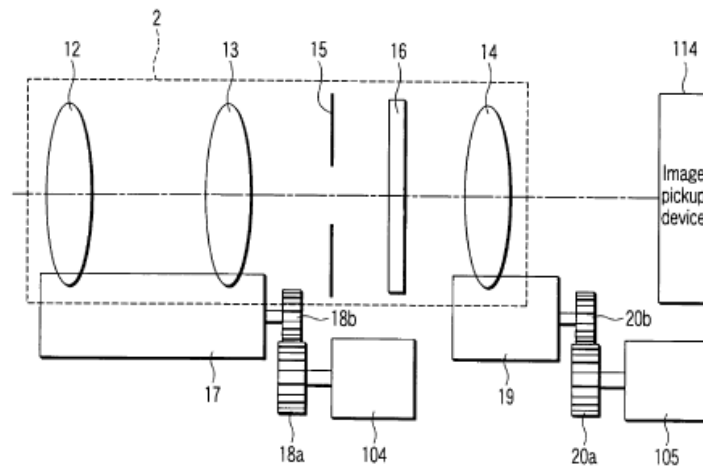


FIG. 2

(EX1004, [0069], [0072], FIG. 2; EX1002, ¶31.)

The CCD and other components are controlled by camera circuitry including a sequence control circuit 119:

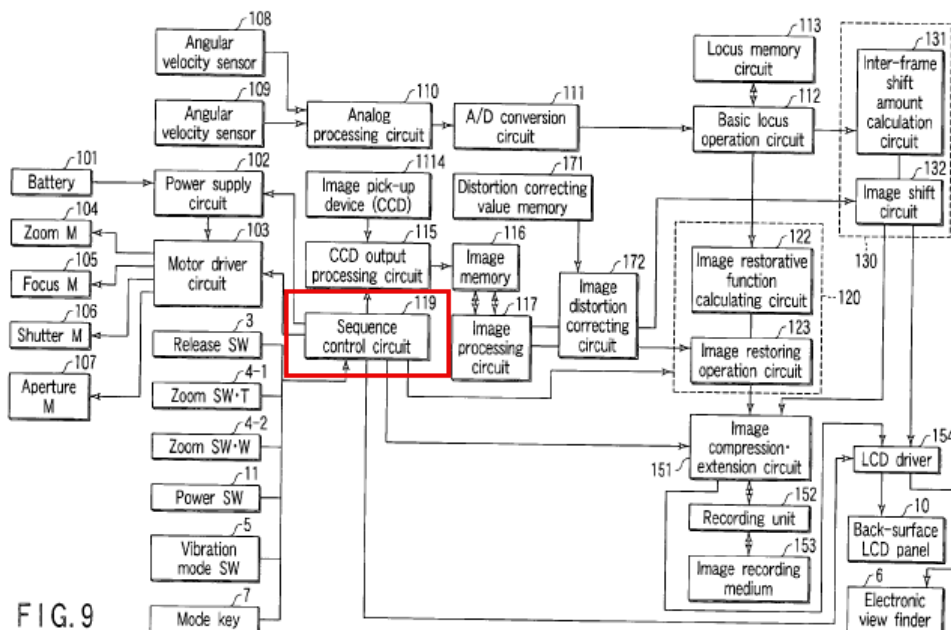
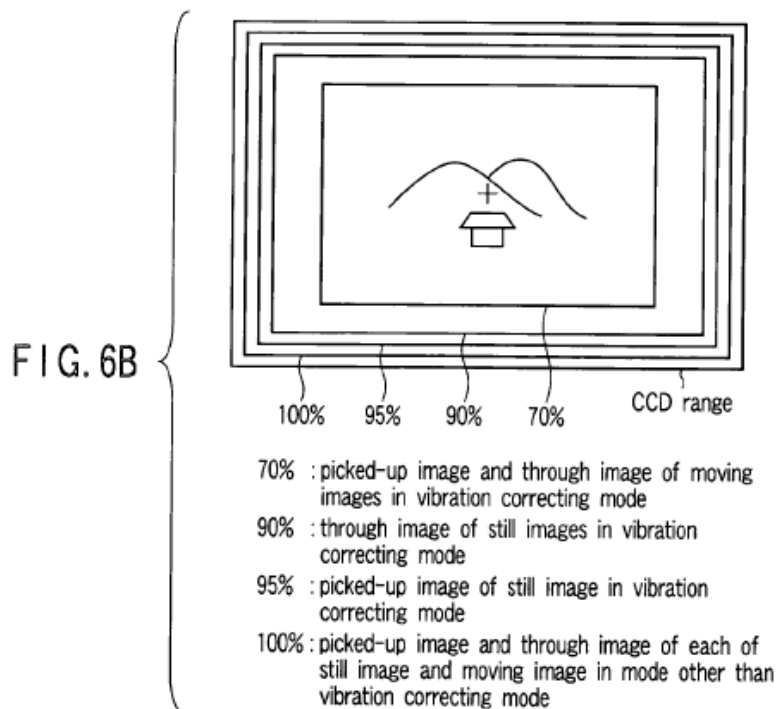


FIG. 9

(EX1004, [0073], [0075], [0106]-[0107], FIG. 9 (annotated); EX1002, ¶32.)

The camera circuitry performs lens distortion correction and electronic

vibration correction. (EX1004, [0106]; EX1002, ¶33.) The vibration correction is applied to picked-up images that are “image cutout ranges” of the CCD image, *e.g.*, via an image restorative function such as shown in FIGS. 7 and 8. (EX1004, [0087]-[0088], [0092], FIGS. 6A-6B, 7, 8; EX1002, ¶33.) These picked-up images have a smaller diagonal length than the full-range CCD image (*e.g.*, having a diagonal-length ratio of 70 percent), and thus exhibit a smaller field-of-view than the CCD image. (EX1004, [0087]-[0088], FIG. 6B; EX1002, ¶33.) The picked-up images can be selected based on metadata indicating, *e.g.*, whether the image is captured in a moving image mode or a still image mode:



(EX1004, FIG. 6B; EX1002, ¶33.)

A two-stage lens distortion correction process is applied to the picked-up images, such as shown in FIG. 12:

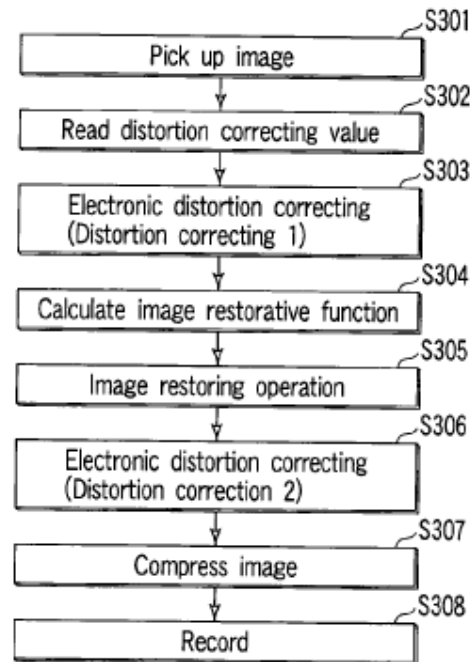


FIG. 12

(EX1004, [0113], FIG. 12; EX1002, ¶34.)

In stage S303 of the process, lens image distortion (e.g., barrel distortion or pincushion distortion) in the picked-up images is corrected to an initial target level of zero distortion (L_0), as shown in FIG. 11D. (EX1004, [0113], FIG. 11D; EX1002, ¶35.) This is so the image restoring operation (S305) can be applied to the picked-up images. (EX1004, [0113]; EX1002, ¶35.) FIG. 11D illustrates:

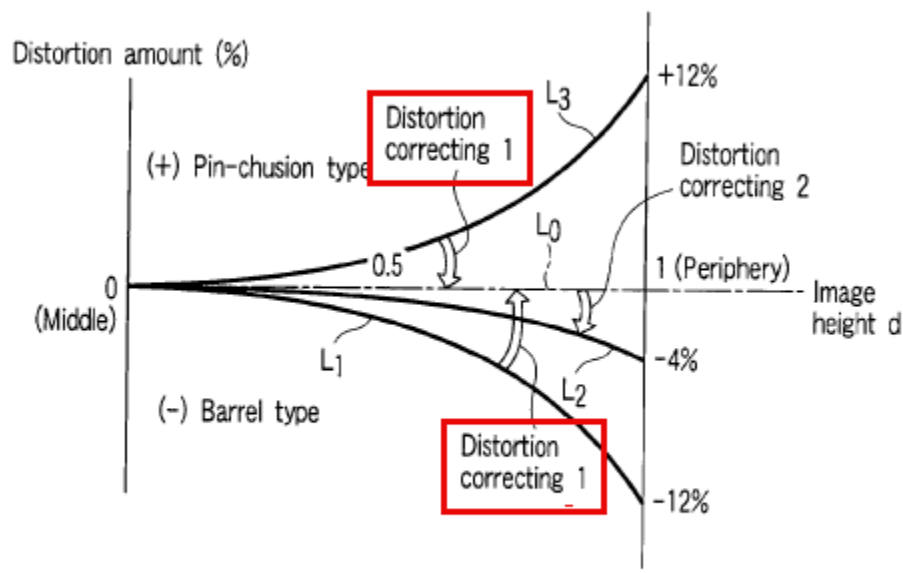


FIG. 11D

(EX1004, FIG. 11D (annotated); EX1002, ¶35.)

However, Okubo explains that “fluctuations are inevitably generated in lens properties,” causing the distortion to shift from zero after the first distortion correction is applied. (EX1004, [0110]; EX1002, ¶36.) To account for such fluctuations, Okubo discloses applying a second distortion correction (S306), in which lens distortion (*e.g.*, barrel distortion) is intentionally introduced in order to restore the image “without any sense of incongruity.” (EX1004, [0112]; EX1002, ¶36.) As Okubo discloses, this intentional distortion is “preferable” to fluctuations that can cause a corrected image to shift from zero distortion and appear “conspicuously unnatural.” (EX1004, [0112]; EX1002, ¶36.) The second distortion correction can be applied as an inverse of the first distortion correction. (EX1004, [0112]; EX1002, ¶36.) FIG. 11D illustrates:

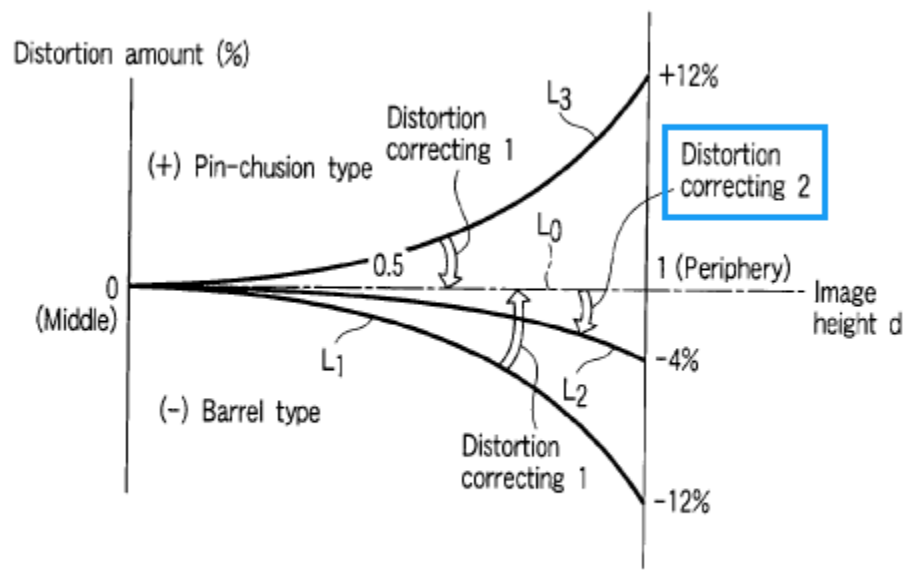


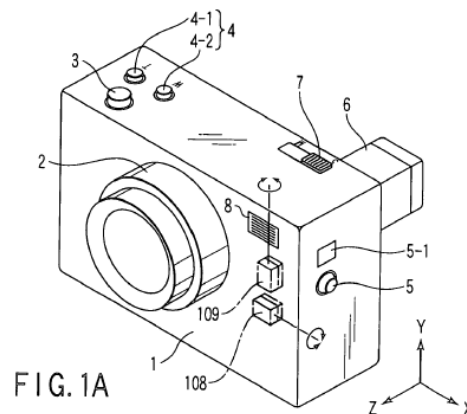
FIG. 11D

(EX1004, [0111]-[0112], FIG. 11D (annotated); EX1002, ¶36.)

2. Claim 1

- a. **[Preamble]** *A system that simulates image distortion of a virtual lens in a video, the system comprising:*

Okubo meets the preamble. (EX1002, ¶37.) For example, Okubo discloses an “image pick-up apparatus and an image restoration method,” such as for a video camera with a lens, *e.g.*, as shown in FIG. 1A:



(EX1004, [0003], [0005], [0067], FIG. 1A; EX1002, ¶37.)

Image distortion of a virtual lens is simulated at least by the process illustrated in FIG. 12, which applies a two-stage distortion correction to picked-up images, as described further below for [1F]:

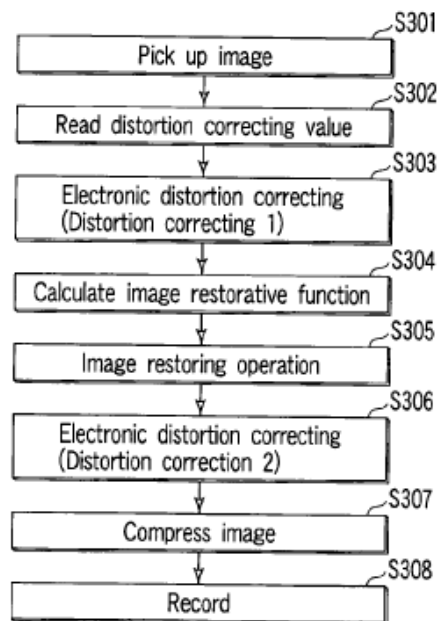


FIG. 12

(EX1004, [0113], FIG. 12; EX1002, ¶38.)

b. [1A] *one or more processors; and*

Okubo meets this element. (EX1002, ¶39.) For example, Okubo discloses, with respect to “a control circuit of the digital camera” shown in FIG. 3 and FIG. 9, that “sequence control circuit 119 comprises a CPU such as a microprocessor.”

(EX1004, [0079], [0106]; EX1002, ¶39.)

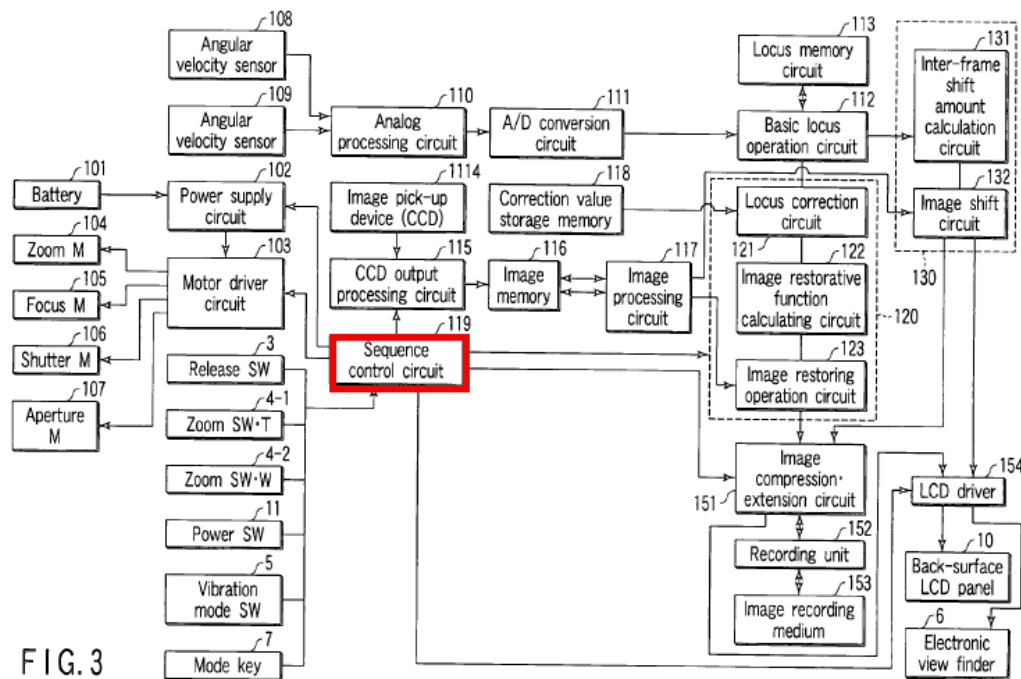


FIG. 3

(EX1004, FIG. 3 (annotated); *see also* EX1004, [0106], FIG. 9; EX1002,

¶39.)

- c. **[1B] a non-transitory computer-readable storage medium storing instructions that when executed cause the one or more processors to perform steps including:**

Okubo meets this element. (EX1002, ¶40.) For example, as described above, Okubo discloses that the control circuit’s “sequence control circuit 119 comprises a CPU such as a microprocessor,” and that sequence control circuit 119 has “instructions.” (EX1004, [0073], [0079]; EX1002, ¶40.) Okubo further discloses that the sequence control circuit 119 “functions as a sequence controller, a continuous operation unit which continuously operates the image pick-up device, a display control unit which controls the display of the monitor (view finder 6,

back-surface LCD panel 10), and controllers of first and second vibration correcting units (image restoring operation circuit 123, image shift circuit 132).” (EX1004, [0079]; EX1002, ¶40.) Sequence control circuit 119 can be configured to perform the process shown in FIG. 12, at least via the controllers of the first and second vibration correcting units. (EX1004, [0113], FIG. 12; EX1002, ¶40.)

To the extent it is not expressly disclosed in Okubo, it would have been obvious to the POSITA that the digital camera’s control circuit includes a non-transitory computer-readable storage medium, and that sequence control circuit 119 performs the above functions by executing instructions stored on that storage medium. (EX1002, ¶41.) This is at least because the POSITA would understand a digital camera, such as in Okubo, to be an embedded computer system in which one or more processors (e.g., the CPU of sequence control circuit 119) execute instructions stored in a non-transitory memory. (EX1006, 95-97, 15, 33-34; EX1002, ¶41.) And as the POSITA would understand, “without a memory from which the processors can read and write information, there would be no stored-program digital computers.” (EX1006, 34; EX1002, ¶41.)

- d. ***[1C] accessing input images, the input images including fields of view of a scene captured through a lens of a camera, the input images depicting the scene with an input lens distortion centered in the fields of view;***

Okubo meets this element. (EX1002, ¶42.) For example, Okubo discloses

that an image pick-up device 114 (*e.g.*, a CCD) is positioned behind a lens such that light passing through the lens forms an image on the CCD:

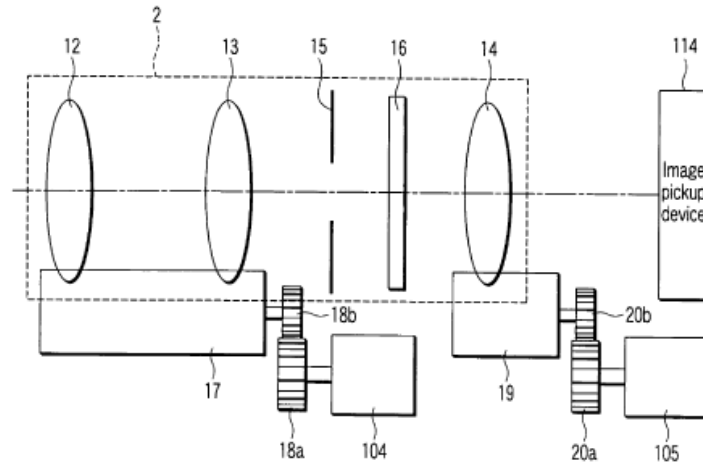
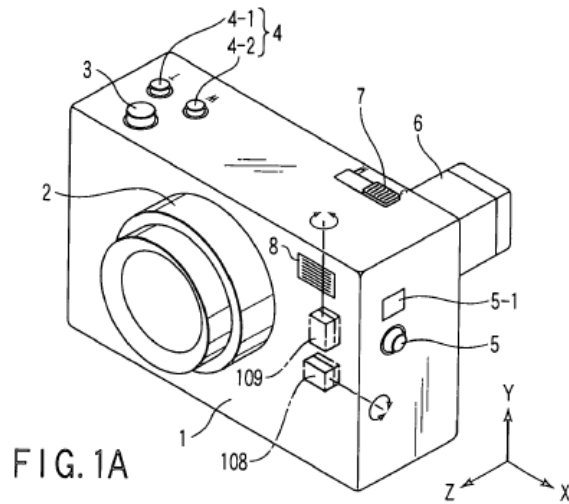


FIG. 2

(EX1004, [0069], [0072], FIG. 2; EX1002, ¶42.)

Input images formed on the CCD are accessed at least by CCD output processing circuit 115, which processes the output of the CCD 114; and by additional circuit elements (*e.g.*, image processing circuit 117, image distortion correcting circuit 172), which access the input image via image memory 116, such as shown in FIG. 9:



(EX1004, [0003], [0005], [0067], [0072] FIGS. 1A, 6B; EX1002, ¶44.)

The POSITA would further recognize that the input images in Okubo depict the scene with an input lens distortion centered in the fields of view. (EX1002, ¶45.) This is evident to the POSITA at least from FIG. 2, which illustrates that the axes of lenses 12, 13, 14 are centered with respect to the image pick-up device 14:

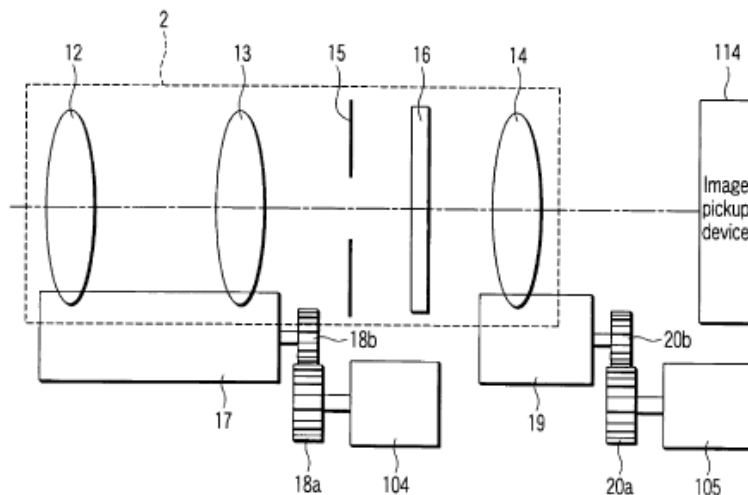


FIG. 2

(EX1004, FIG. 2; EX1002, ¶45.)

Moreover, FIGS. 11D and 11E illustrate lens distortion as a function of an image height from the center of the field of view, and indicate the lens distortion (e.g., L_1 , L_3) is symmetric about the axis at which the image height d is zero (e.g., the image center):

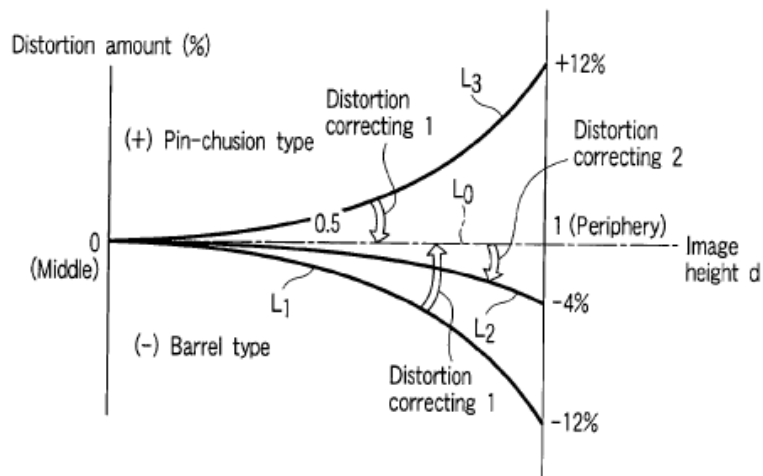


FIG. 11D

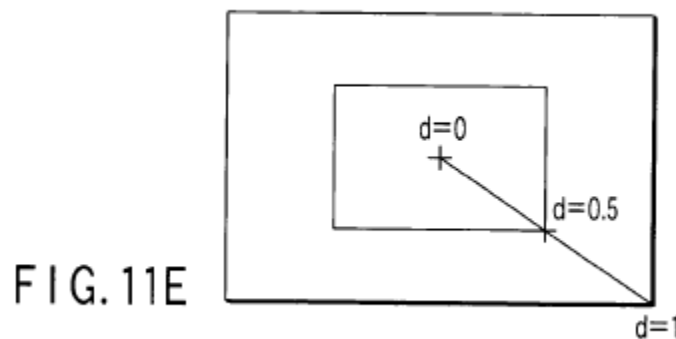
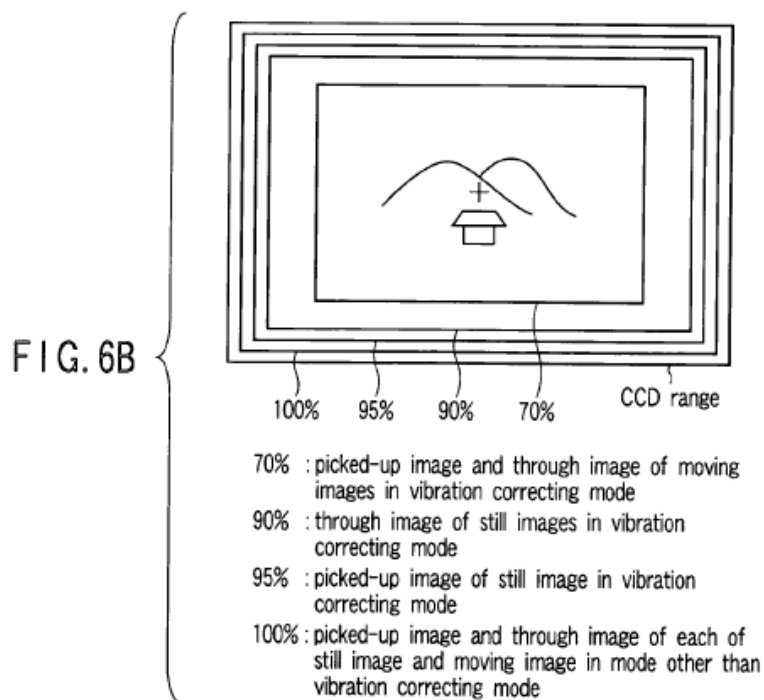


FIG. 11E

(EX1004, [0109], [0111], FIGS. 11D, 11E; EX1002, ¶46.)

- e. **[1D] selecting sub-frames representing portions of the input images, the sub-frames including reduced fields of view of the scene smaller than the fields of view of the input images,**

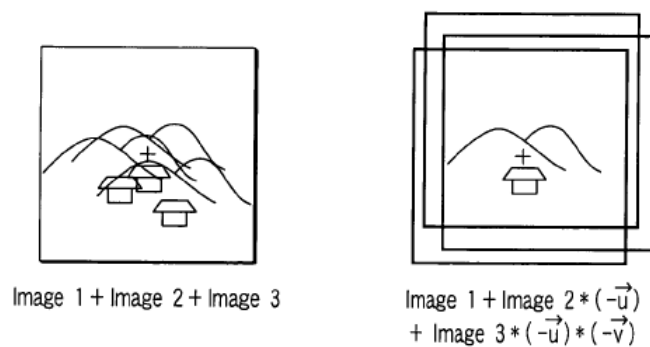
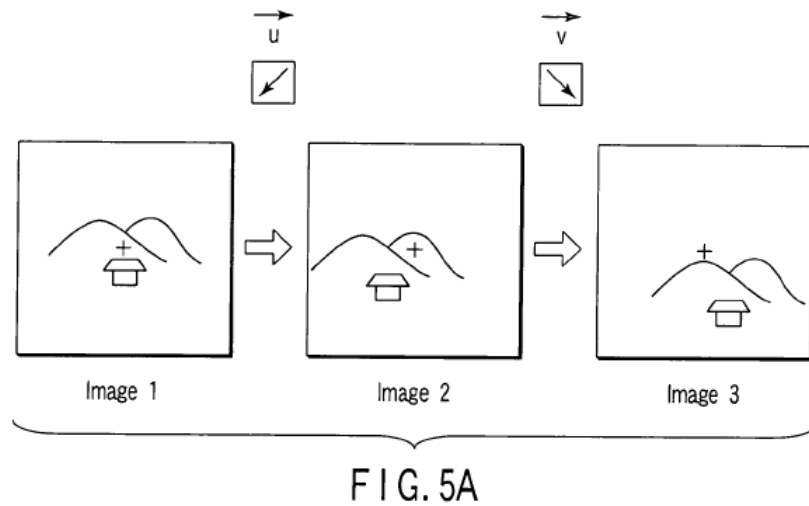
Okubo meets this element. (EX1002, ¶47.) For example, as part of the distortion correction process illustrated in FIG. 12, Okubo selects (S301) picked-up images that are “image cutout ranges,” or cropped sub-frames, of the CCD images. (EX1004, [0087]-[0091], FIG. 6B; EX1002, ¶47.) FIG. 6B illustrates example relationships between the sub-frames and the CCD image:



(EX1004, [0087]-[0091], FIG. 6B, *see also* FIGS. 7, 8; EX1002, ¶47.)

As illustrated in the figure, the sub-frames represent portions of the input images (*e.g.*, full-range CCD images) that have a smaller diagonal length than the

input images. (EX1004, [0087]-[0091], FIG. 6B; EX1002, ¶48.) A desired diagonal-length ratio of each sub-frame to the input image is determined based on whether a moving image mode, a still image mode, and/or a vibration correcting mode is active. (EX1004, [0087]-[0091], FIG. 6B; EX1002, ¶48.) For example, compared to the input images, sub-frames can have a diagonal-length ratio of, *e.g.*, 70 percent, 90 percent, or 95 percent; and thus exhibit a smaller field-of-view of the scene than in the input images. (EX1004, [0087]-[0088], FIG. 6B; EX1002, ¶48.) Further, Okubo discloses selecting multiple sub-frames, at least as shown by the selection of Image 1, Image 2, and Image 3 in FIGs. 5A-5C, illustrating “three varying frames”:



(EX1004, [0085], FIGS. 5A-5C; EX1002, ¶48.)

Okubo's selection of sub-frames by cropping the input image is analogous to the '052 patent's description that "the sub-frame may be selected as ... a crop of the original input image or video frame." (EX1001, 11:47-51; EX1002, ¶49.) The '052 patent notes that such cropping operations are "often desirable." (EX1001, 1:14-16; EX1002, ¶49.) Moreover, Okubo's selection of sub-frames based on a desired diagonal-length ratio is analogous to the '052 patent's description of

obtaining a “scaling factor,” defined as “a ratio of a size of the input image to the sub-frame size,” and using that scaling factor to crop the input image and thus select the sub-frames. (EX1001, 5:52-64; EX1002, ¶49.)

- f. ***[1E] the sub-frames including different lens distortion effects as a function of the input lens distortion present in the input images, different positions of areas of the input images included within the reduced fields of view, and a size of the areas of the input images included within the reduced fields of view; and***

Okubo meets this element. (EX1002, ¶50.) For example, Okubo discloses that images—and thus sub-frames of those images—can include different lens distortion effects, such as barrel distortion (shown in FIG. 11B) or pincushion distortion (FIG. 11C):

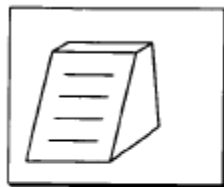


FIG. 11A



FIG. 11B



FIG. 11C

(EX1004, [0109]-[0110], FIGS. 11A-11D; EX1002, ¶50.) Okubo discloses that “with regard to areas other than the screen middle, the lenses 12, 13, 14 of the digital camera generate the distortions of the images which are dependent on zoom and focus positions.” (EX1004, [0072], [0076]; EX1002, ¶50.) This lens distortion in Okubo is analogous to the ’052 patent’s disclosure that lens

characteristics including magnification and focal length—analogous to Okubo’s zoom and focus positions—can affect the lens distortion. (EX1001, 7:40-44; EX1002, ¶50.)

The POSITA would understand the lens distortion effects in the sub-frames to be a function of the input lens distortion in the input images represented by the sub-frames. (EX1002, ¶51.) For example, FIG. 11D illustrates various distortion effects in an input image (*e.g.*, input distortion effects L_1 , L_3); Okubo explains that the distortion effects such as L_1 can represent an “image distortion ... by the lens,” such as barrel type distortion. (EX1004, [0111], FIG. 11D; EX1002, ¶51.) FIGs. 11D and 11E show how different lens distortion effects in an image can be expressed based on their location within the image:

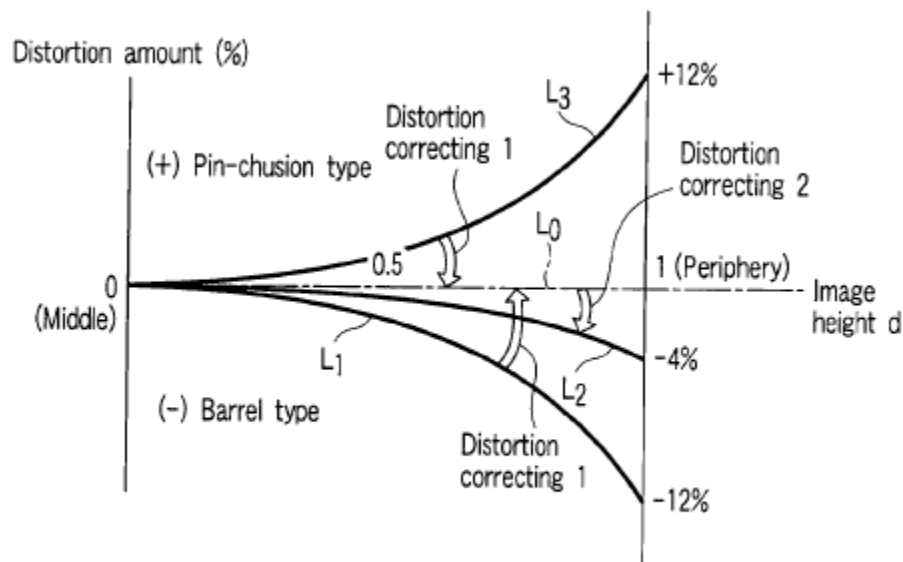
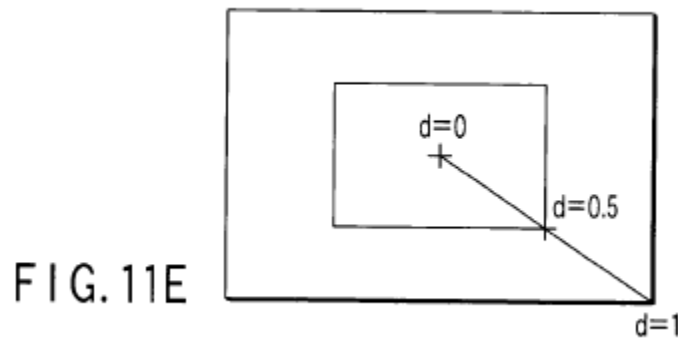


FIG. 11D



(EX1004, [0109], [0111], FIGs. 11D-11E; EX1002, ¶51.) The POSITA would understand FIGs. 11D and 11E to show that the amount of input lens distortion (e.g., L_1 , L_3) in any area of an input image can be determined as a function of image height d , where the image height d represents a distance from the center of an image (*i.e.*, such that an image height of $d=0$ represents the center of the image, and an image height of $d=1$ represents the periphery of the image). (EX1004, FIGs. 11D-11E, [0109], [0111]; EX1002, ¶51.) For example, an area of the image at an image height of $d=0.5$ may have a first amount of input lens distortion (corresponding to, *i.e.*, the value of L_1 or L_3 at $d=0.5$); and an area of the image at an image height of $d=0.75$ may have a second, different, amount of input lens distortion (corresponding to, *i.e.*, the value of L_1 or L_3 at $d=0.75$). (EX1004, FIG. 11D, [0109], [0111]; EX1002, ¶51.)

The POSITA would further understand FIGs. 11D and 11E to describe the lens distortion effects in a sub-frame, which is simply a portion of an input image, such as described above for [1D]. (EX1004, [0087]-[0091], FIG. 6B; EX1002,

¶52.) The POSITA would understand the lens distortion effects to be a function of the input lens distortion in the input image. (EX1002, ¶52.) For example, the POSITA would understand that a lens distortion effect in an area of the sub-frame can be determined as a function of the input lens distortion, by determining the input lens distortion in the input image that corresponds to the area of sub-frame, such as described above for FIGs. 11D and 11E. (EX1002, ¶52.) The POSITA would further understand the sub-frames to include different lens distortion effects as a function of different positions of areas of the input images included within the reduced fields of view, and a size of the areas of the input images included within the reduced fields of view. (EX1002, ¶52.) This is at least because, as described above for FIGs. 11D and 11E, the lens distortion effects in an input image—and thus a sub-frame of that image—are expressed as a function of the position and/or size (*i.e.*, image height d) of an area within the input image. (EX1002, ¶52.) For example, as shown in FIG. 11D and described above, image areas having different values for image height d may exhibit different lens distortion effects as a function of that image height. (EX1004, FIGs. 11D; EX1002, ¶52.)

The POSITA would additionally understand Okubo to teach that the sub-frames include multiple different distortion effects. (EX1002, ¶53.) For example, as described above, FIG. 11D illustrates that an input image (and thus a sub-frame of that input image) can include various lens distortion effects that differ

throughout the input image, for instance as the distance from the center of the image changes. (EX1002, ¶53.) Further, as Okubo discloses, these effects may differ “dependent on zoom and focus positions.” (EX1004, [0072], [0076]; EX1002, ¶53.) Additionally, Okubo explains that for “areas other than the screen middle,” the lens distortion is corrected by “correction data...corresponding to each area of the screen.” (EX1004, [0076], [0108]; EX1002, ¶53.) The POSITA would thus understand that different areas of the screen (and thus an input image) may include different lens distortion effects, requiring different distortion correction data. (EX1004, [0076], [0108]; EX1002, ¶53.) And Okubo further discloses that lens distortion may “differ[] with each area because of so-called straw hat type distortion,” which is “a mixture of the pin-cushion and barrel type distortions.” (EX1004, [0112]; EX1002, ¶53.)

- g. ***[1F] generating output images based on a desired lens distortion and the different lens distortion effects in the sub-frames, the desired lens distortion and the input lens distortion exhibiting consistent lens characteristics,***

Okubo meets this element. (EX1002, ¶54.) For example, Okubo discloses a process in FIG. 12 in which output images are generated (S308) by applying two stages (S303, S306) of lens distortion correction to the sub-frames (S301):

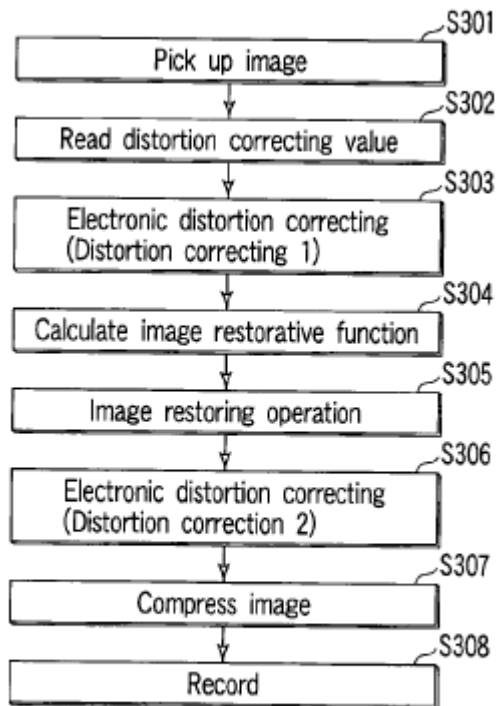


FIG. 12

(EX1004, [0106]-[0113]; EX1002, ¶54.)

In stage S302, a distortion correcting value corresponding to the lens distortion is read from a distortion correcting value memory 171, based on the zoom position and the subject distance. (EX1004, [0113], FIG. 12; EX1002, ¶55.)

At stage S303, the distortion correcting values are applied to the sub-frames to correct the lens image distortion into a first desired lens distortion level L_0 , indicating zero distortion. (EX1004, [0113], FIGS. 11D, 12; EX1002, ¶55.) FIG. 11D (“Distortion correcting 1”) illustrates correction of lens distortions L_1 and L_3 to L_0 according to stage S302:

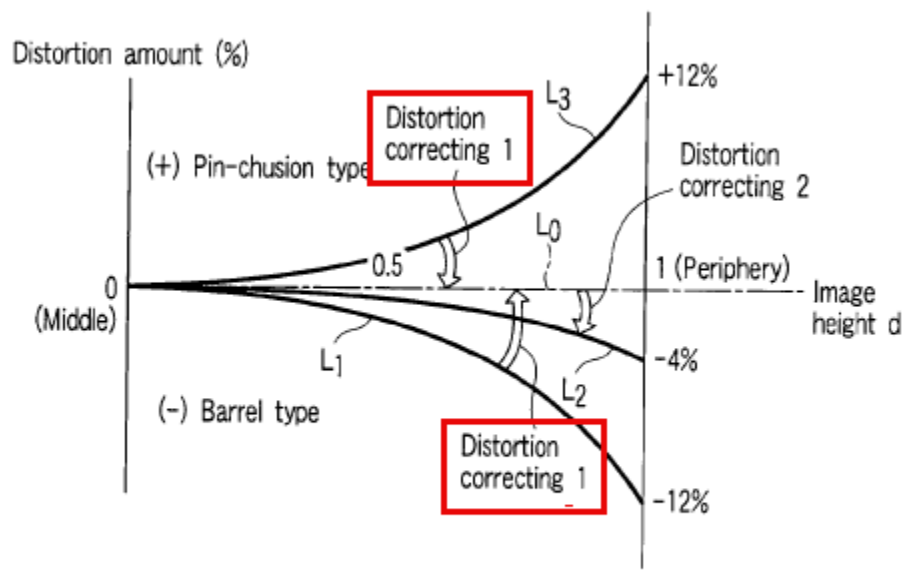


FIG. 11D

(EX1004, [0111]-[0113], FIG. 11D (annotated); EX1002, ¶55.)

Then, at stage S306, to account for fluctuations in lens properties and to generate an image “without any sense of incongruity,” lens distortion is intentionally introduced (*e.g.*, via an inverse correction of the first distortion correction) to obtain a second desired lens distortion level L_2 , *e.g.*, simulating a non-zero amount of barrel distortion. (EX1004, [0112]-[0113], FIG. 12; EX1002, ¶56.) FIG. 11D (“Distortion correcting 2”) illustrates a correction of lens distortion L_0 to L_2 , indicating barrel distortion, according to stage S306:

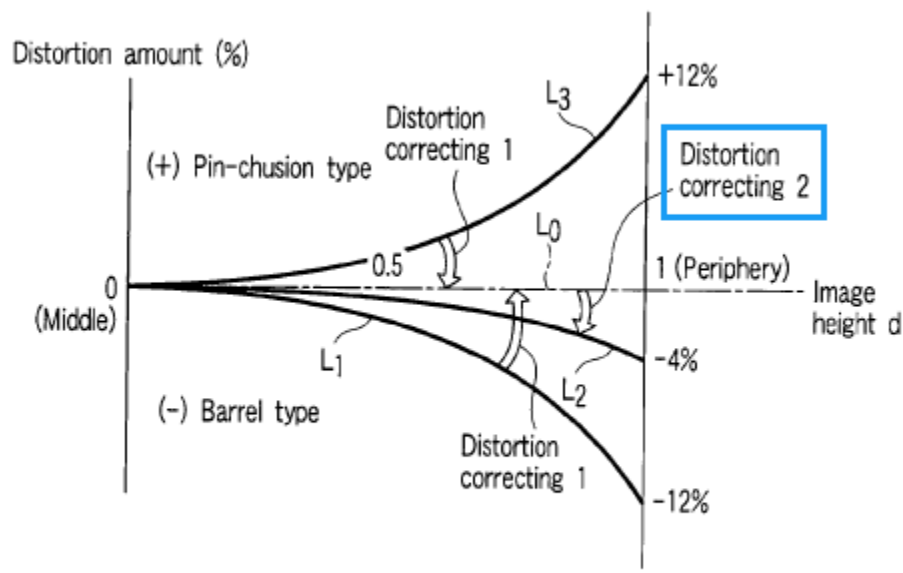


FIG. 11D

(EX1004, [0111]-[0113], FIG. 11D (annotated); EX1002, ¶56.)

Okubo’s two-stage distortion process of FIG. 12 is analogous to the “two-step transformation” described in the ’052 patent, in which a first step is performed to “remove the lens distortion present in the sub-frame,” and a second step is then performed to “re-introduce a lens distortion effect.” (EX1001, 12:25-42; EX1002, ¶57.)

The output images are based on the different lens distortion effects at least because the first distortion correction applies distortion correcting values stored in the distortion correcting value memory 171, which are associated with the different lens distortion effects as described above for [1E]. (EX1004, [0108]; EX1002, ¶58.) For instance, the distortion correcting values are read from the memory 171 “based on zoom position and subject distance” and applied to correct the lens

distortion. (EX1004, [0108]; EX1002, ¶58.)

The desired lens distortion and the input lens distortion exhibit consistent lens characteristics at least because, in order to obtain the desired lens distortion L_2 , the image distortion correcting circuit 172 at stage S303 first applies to the sub-frame distortion correcting values that “correspond[]” to the input lens distortion; and stage S306 then applies the “inverse correction” of stage S303 to obtain the desired lens distortion L_2 . (EX1004, [0111]-[0112]; EX1002, ¶59.) As Okubo explains, the image distortion correcting circuit 172 operates as a “lens property correction circuit,” such that “the aberration attributed to the properties of the photographing lens or the like may be corrected.” (EX1004, [0107]-[0108]; EX1002, ¶59.) The POSITA would recognize that by applying an inverse correction of stage S303, stage S306 inversely applies the distortion correcting values of S303 that correspond to the input lens distortion; and that the desired lens distortion L_2 and the input lens distortion thus exhibit distortion characteristics of the same lens. (EX1004, [0111]-[0112]; EX1002, ¶59.)

Additionally, Okubo discloses that in obtaining the desired lens distortion L_2 , the distortion “shifts from zero” by “fluctuations in the lens properties,” thus introducing into the output image the fluctuations of the input lens distortion during stage S303, when the distortion is first corrected to the intermediate desired level L_0 . (EX1004, [0110]-[0111]; EX1002, ¶60.) Both the desired lens distortion

and the input lens distortion thus exhibit the same fluctuation characteristics of the lens, providing another reason why the desired lens distortion and the input lens distortion exhibit consistent lens characteristics. (EX1004, [0110]; EX1002, ¶60.)

Moreover, the output image is restored “without any sense of incongruity,” and as the POSITA would understand based on experience with image or video processing, a sense of incongruity could result if the desired lens distortion in the output images were not consistent with the characteristics of the lens of the camera. (EX1004, [0112]-[0113]; EX1002, ¶61.) Okubo’s output images are thus consistent with the ’052 patent’s goal of generating images with “consistent lens characteristics” such that it is “not apparent to the viewer” that editing effects were created in post-processing instead of during capture. (EX1001, 3:39-43; EX1002, ¶61.)

- h. ***[1G] wherein the output images include the sub-frames remapped from the input lens distortion centered in the fields of view of the input images to the desired lens distortion centered in the reduced fields of view to transform the different lens distortion effects present in the sub-frames to the desired lens distortion such that portions of the scene depicted in the sub-frames appear to have been captured using the reduced fields of view.***

Okubo meets this element. (EX1002, ¶62.) As described above for [1F], the output images include the sub-frames remapped from the input lens distortion to the desired lens distortion. (EX1002, ¶62.) For example, the input lens distortion

is centered in the fields of view as described above for [1C]; and with respect to the output images, FIGS. 11D and 11E illustrate that the desired lens distortion L_2 can be symmetric about the axis at which the image height d is zero (*i.e.*, the image center), and thus centered with respect to the field of view:

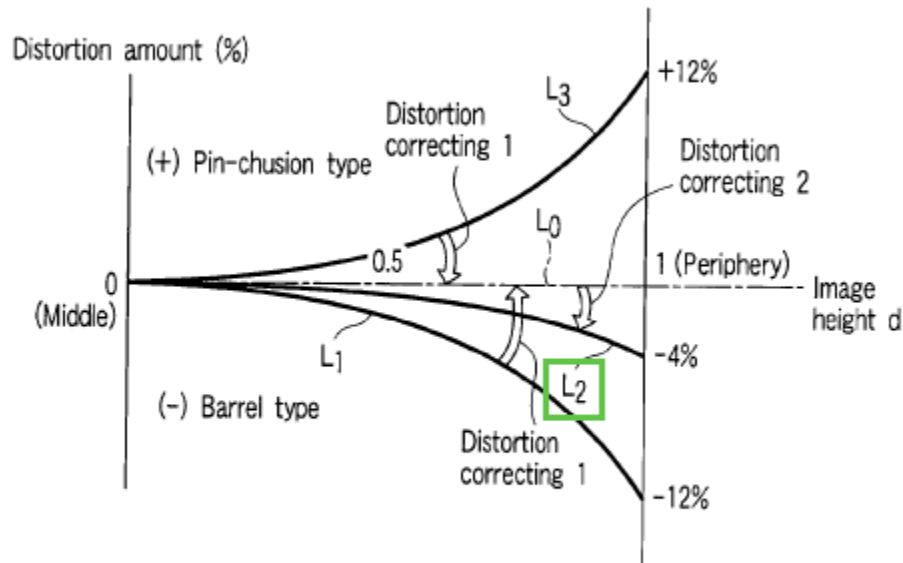


FIG. 11D

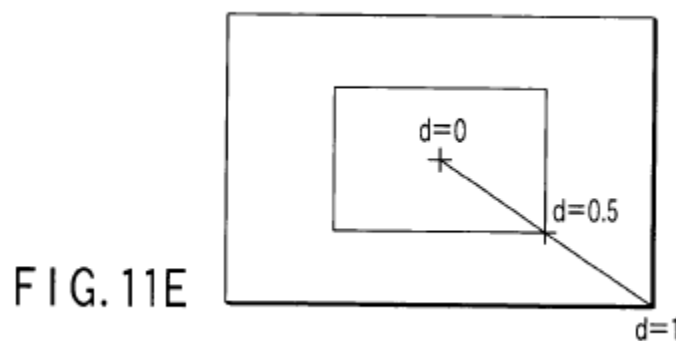


FIG. 11E

(EX1004, [0109], [0111]-[0113], FIG. 11D (annotated), 11E; EX1002, ¶62.)

In transforming the lens distortion effects of the sub-frames to the desired

lens distortion L_2 , as described above for [1F], the scene depicted appears to have been captured using the reduced fields of view of the sub-frames. (EX1004, [0106]-[0113]; EX1002, ¶63.) This is because by applying the two-stage correction process of FIG. 12, “the image is obtained without any sense of incongruity by both of the distortion correcting into zero (distortion correcting [1]) and the inverse correction into the barrel type (distortion correcting 2),” such as described above. (EX1004, [0112]-[0113]; EX1002, ¶63.) For example, the image can exhibit lens distortion L_2 shown in FIG. 11D. (EX1004, [0109],[0111]; EX1002, ¶63.) Fig. 5C illustrates an example output image in which portions of a scene depicted in the sub-frame (*e.g.*, a house and surrounding hills) appear to have been captured by the camera lens using the reduced field of view:

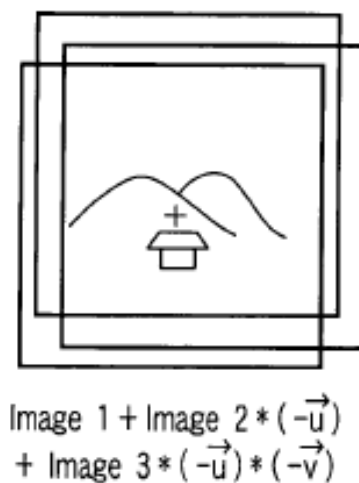


FIG. 5C

(EX1004, [0085], FIG. 5C; EX1002, ¶63.)

Moreover, the POSITA would understand based on experience with image or video processing that the image in Okubo obtained without any sense of incongruity meets an image that appears to have been captured using its reduced fields of view, as recited in the claim. (EX1002, ¶64.) This is at least because it would appear incongruous for Okubo's camera to generate an image that did not appear to have been captured by the lens of that camera using the image's own field of view (that is, the reduced field of view of the picked-up image such as illustrated in FIG. 6B). (EX1004, FIG. 6B; EX1002, ¶64.) That is, the observer would find such an image "conspicuously unnatural" and unfamiliar due to the mismatch between the appearance of the image and the optical properties of the lens that captured it. (See EX1004 at [0110]; EX1002, ¶64.)

3. Claim 2

a. [Preamble] *The system of claim 1,*

Okubo meets the preamble as described above for claim 1. (EX1002, ¶65.)

b. [2A] *wherein image stabilization is applied to the input images.*

Okubo meets this element. (EX1002, ¶66.) For example, Okubo discloses that "as correction of the vibration in a still image or the like, a locus of camera shakes is detected using an angular velocity sensor or the like at the time of the image pick-up, and a predetermined image restoring operation is performed based

on the detected locus of the shake after the image pick-up.” (EX1004, [0005]; EX1002, ¶66.) As an illustration of “the electronic vibration correcting,” FIG. 5C “corresponds to an image in which the vibration has been corrected” based on input images:

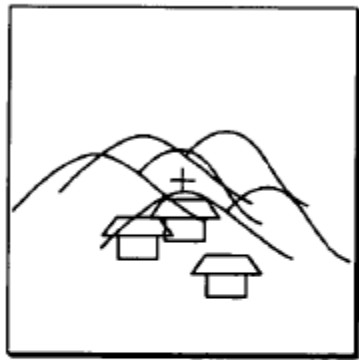


Image 1 + Image 2 + Image 3

FIG. 5B

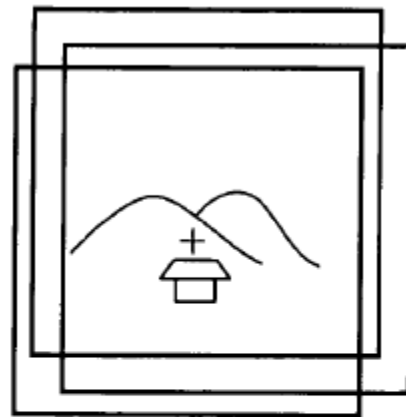


Image 1 + Image 2 * $(-\vec{u})$
+ Image 3 * $(-\vec{u}) * (-\vec{v})$

FIG. 5C

(EX1004, [0085], FIGs. 5B-5C; EX1002, ¶66.)

4. Claim 3

a. [Preamble] *The system of claim 1,*

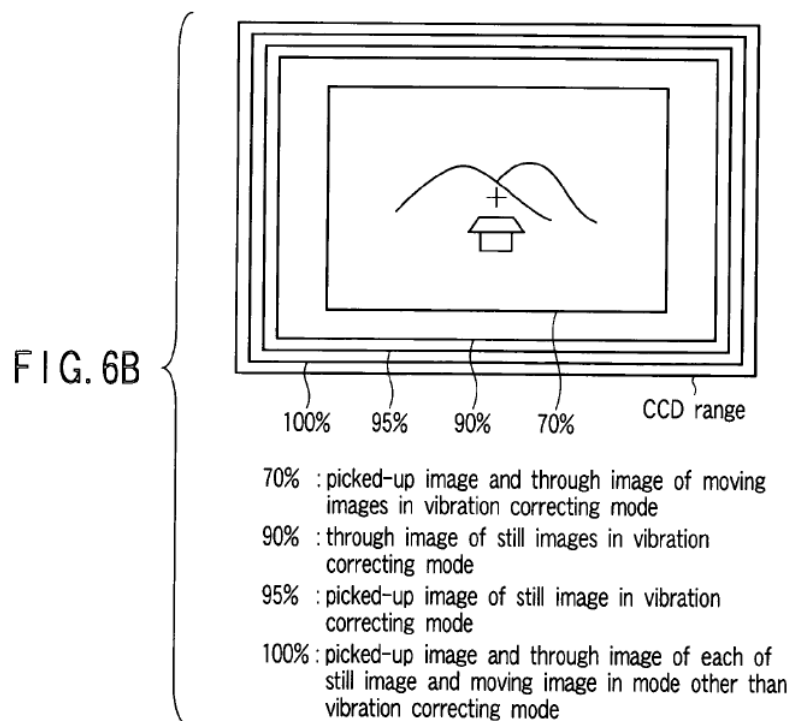
Okubo meets the preamble as described above for claim 1. (EX1002, ¶67.)

b. [3A] *wherein the sub-frames are selected based on metadata associated with the input images.*

Okubo meets this element. (EX1002, ¶68.) For example, Okubo’s sub-

frames are selected based on metadata indicating whether the input images were captured in a moving image mode or a still image mode, or in a vibration correcting mode. (EX1004, [0087]-[0091], FIG. 6B; EX1002, ¶68.) These modes are metadata associated with the input images: for example, the camera can include a mode key indicating a still image or a moving image. (EX1004, [0069]; EX1002, ¶68.) Similarly, the camera can include a vibration mode switch 5, indicating whether a “vibration correcting flag” is set. (EX1004, [0092]; EX1002, ¶68.)

As shown in FIG. 6B, the size of a sub-frame can depend on the above metadata:



(EX1004, [0087]-[0089], FIG. 6B; EX1002, ¶69.)

As shown in FIG. 6B, if the metadata indicates the moving image mode and the vibration correcting mode, the picked-up image and through image have a range of 70 percent of the diagonal length ratio. (EX1004, [0087]-[0091], FIG. 6B; EX1002, ¶70.) The picked-up image and through image can have other ranges (*e.g.*, 95 percent, 90 percent) based on different values of the metadata. (EX1004, [0087]-[0091], FIG. 6B; EX1002, ¶70.)

As another example, as shown in FIGs. 7-8, it is determined at stage S106 whether the still image mode or moving image mode is indicated; and it is determined at stages S107, S114, S120, and S126 whether the vibration correcting flag is set. (EX1004, [0092]-[0098], FIGs. 7-8; EX1002, ¶71.) The picked-up image and/or the through image is then selected accordingly based on this metadata. (EX1004, [0092]-[0098], FIGs. 7-8; EX1002, ¶71.)

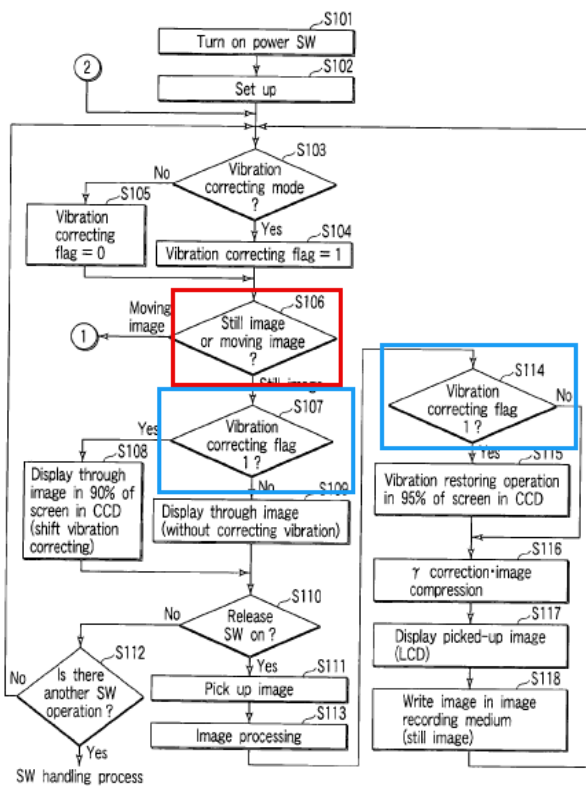


FIG. 7

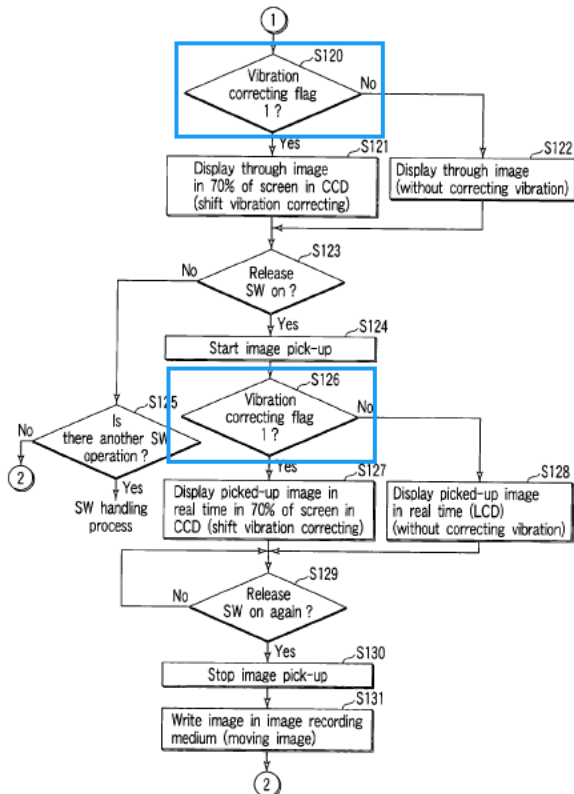


FIG. 8

(EX1004, [0092]-[0098], FIGs. 7-8; EX1002, ¶71.)

Additionally, Okubo's metadata can include data from angular velocity sensors or angular acceleration sensors of the camera, which can indicate displacement angles in the X, Y, and Z axes. (EX1004, [0074]; EX1002, ¶72.) This is consistent with the '052 patent, in which "sensors 440 may capture various metadata," and can include "orientation sensors" or "accelerometers," analogous to Okubo's angular acceleration sensors. (EX1001, 4:22-26, 4:54-58, 8:42-54; EX1007, 19-21, 24; EX1002, ¶72.)

5. Claim 4

a. [Preamble] *The system of claim 3,*

Okubo meets the preamble as described above for claim 3. (EX1002, ¶73.)

b. [4A] *wherein the metadata indicates motion of the camera that captured the input images.*

Okubo meets this element. (EX1002, ¶74.) For example, as described above for [3A], the metadata includes indications of modes including a vibration correction mode. (EX1002, ¶74.) At least the vibration correction mode indicates motion of the camera that captured the input images. (EX1002, ¶74.) For example, in the vibration correction mode, indicated by the vibration correcting flag, “a locus of camera shakes is detected using an angular velocity sensor or the like at the time of the image pick-up.” (EX1004, [0005]; EX1002, ¶74.) An angular acceleration sensor can also be used as described above for [3A]. (EX1004, [0074]; EX1002, ¶74.) The claimed motion of the camera is met at least by the camera shakes detected in the vibration correction mode, which can be indicated by displacement angles computed from the sensor output. (EX1004, [0074]; EX1002, ¶74.)

6. Claim 5

a. [Preamble] *The system of claim 3,*

Okubo meets the preamble as described above for claim 3. (EX1002, ¶75.)

b. [5A] *wherein the metadata indicates orientation of the camera that captured the input images.*

Okubo meets this element. (EX1002, ¶76.) For example, as described above for [3A], the metadata can include vibration rotary angles in the X, Y, and Z axes. (EX1002, ¶76.) As Okubo explains, these vibration rotary angles can be used to calculate displacement angles, or can indicate the output of angular acceleration sensors of the camera, thus indicating an orientation of the camera that captured the images. (EX1004, [0074]; EX1002, ¶76; EX1007, 19-21, 24.) This is consistent with the '052 patent's description of sensors, such as accelerometers, that "generate orientation metadata describing the orientation of the camera 330." (EX1001, 8:46-56; EX1002, ¶76.)

7. Claim 6

a. [Preamble] *The system of claim 1,*

Okubo meets the preamble as described above for claim 1. (EX1002, ¶77.)

b. [6A] *wherein the output images are combined as video frames of an output video.*

Okubo meets this element. (EX1002, ¶78.) For example, Okubo discloses that the camera can be a video camera. (EX1004, [0005]; EX1002, ¶78.) The POSITA would understand based on experience with image or video processing that a video camera is configured to produce output video, and that output images of a video camera are combined as video frames of the output video. (EX1002, ¶78; EX1008, 9-10.)

8. Claim 7

a. [Preamble] *The system of claim 6,*

Okubo meets the preamble as described above for claim 6. (EX1002, ¶79.)

b. [7A] *wherein remapping of the sub-frames from the input lens distortion centered in the fields of view of the input images to the desired lens distortion centered in the reduced fields of view results in the output video having consistent frame-to-frame lens characteristics.*

Okubo meets this element. (EX1002, ¶80.) Okubo meets the claimed remapping the sub-frames as described above for [1G]. (EX1002, ¶80.) And as Okubo explains, the remapping restores the image “without any sense of incongruity.” (EX1004, [0112]; EX1002, ¶80.) This meets the output video having consistent frame-to-frame lens characteristics at least because, as the POSITA would understand, a video would include consistent frame-to-frame lens characteristics in order to avoid a sense of incongruity when viewing the video. (EX1002, ¶80.) Put differently, the POSITA would understand that inconsistent frame-to-frame lens characteristics would result in a sense of incongruity, because such inconsistent lens characteristics would result in a mismatch between frames that an observer would find visually jarring. (EX1002, ¶80.)

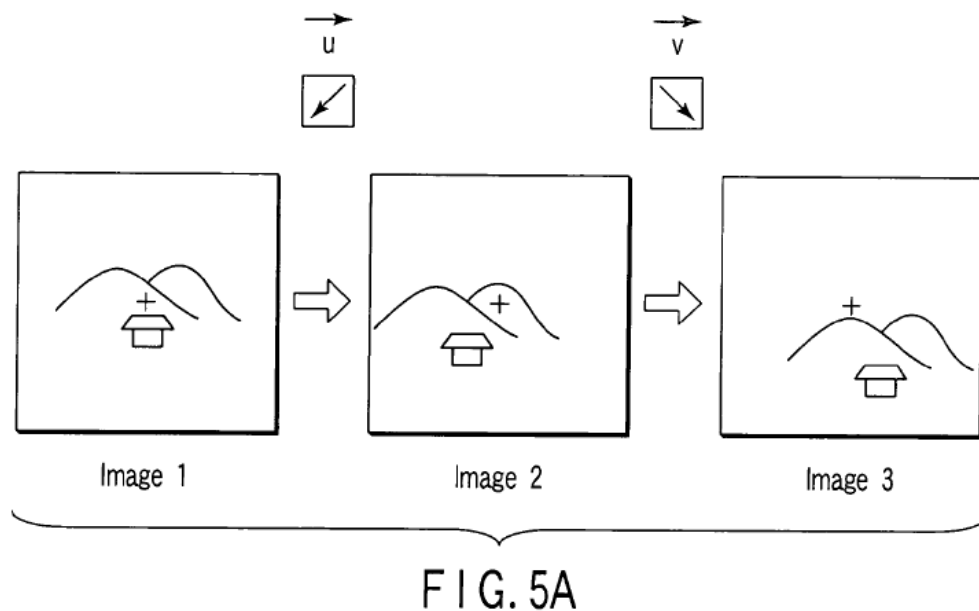
9. Claim 8

a. [Preamble] *The system of claim 7,*

Okubo meets the preamble as described above for claim 7. (EX1002, ¶81.)

- b. [8A] wherein the different positions of the areas of the input images included within the reduced fields of view simulate virtual re-pointing of the camera using the reduced fields of view.

Okubo meets this element. (EX1002, ¶82.) For example, FIG. 5A illustrates areas of the input images included within the reduced fields of view:



(EX1004, [0085]-[0086], FIG. 5A; EX1002, ¶82.)

A shift between the frames is reversed by applying a vector movement in the reverse direction of the shift. (EX1004, [0085]-[0086], FIGs. 5A-5C; EX1002, ¶83.) This results in an output image (shown for example in FIG. 5C, with respect to FIG. 5B) in which the camera is virtually re-pointed with respect to Images 1, 2, and 3:

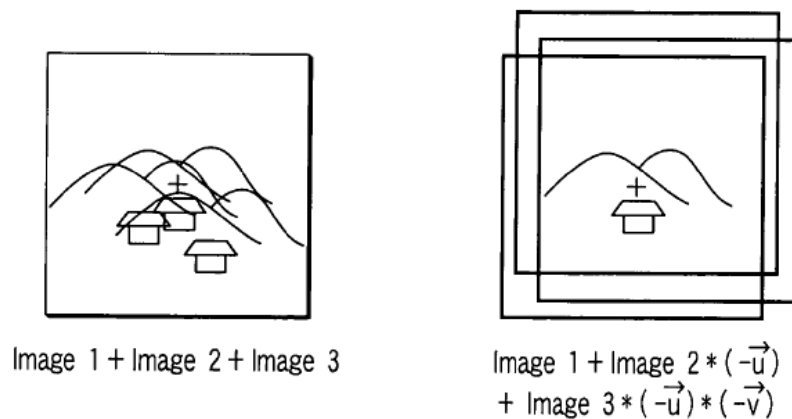


FIG. 5B

FIG. 5C

(EX1004, [0085]-[0086], FIGs. 5B-5C; EX1002, ¶83.)

10. Claim 9

a. [Preamble] *The system of claim 8,*

Okubo meets the preamble as described above for claim 8. (EX1002, ¶84.)

b. [9A] *wherein the one or more processors and the non-transitory computer-readable storage medium are included in the camera.*

Okubo meets this element. (EX1002, ¶85.) For example, at least sequence control circuit 119 of Okubo meets the claimed one or more processors as described above for [1A], and meets the claimed non-transitory computer-readable storage medium as described above for [1B]. (EX1002, ¶85.) FIG. 9 of Okubo illustrates that these components belong to a control circuit of the digital camera, e.g., as shown in FIG. 1A:

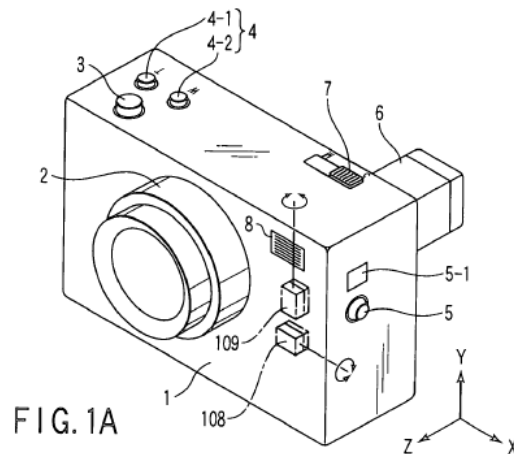


FIG. 1A

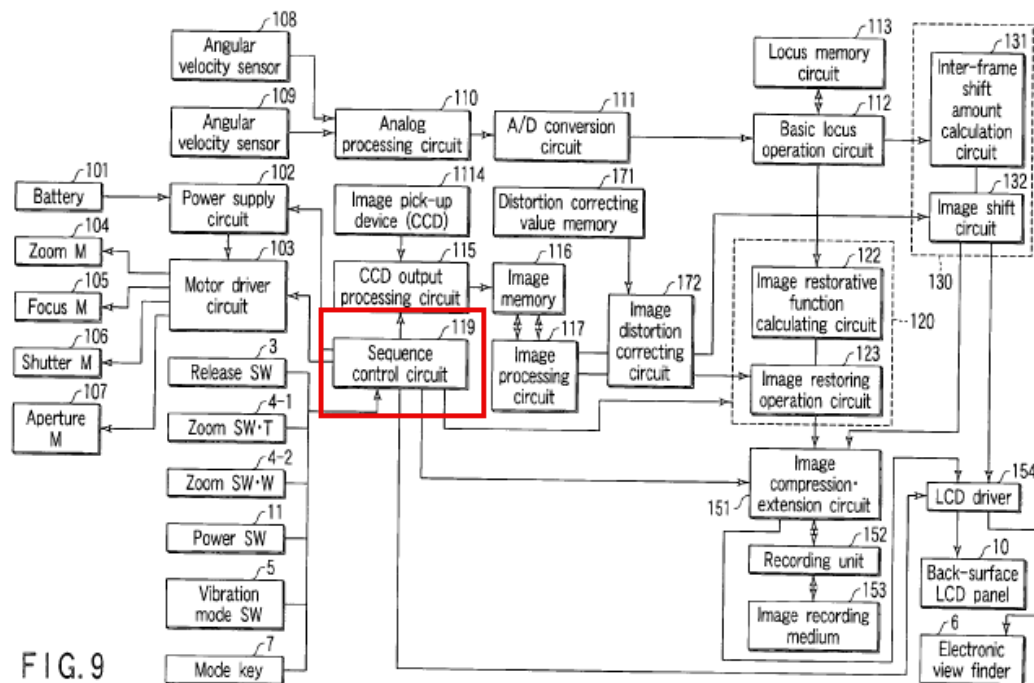


FIG. 9

(EX1004, [0073], [0106], FIGS. 1A, 9 (annotated); EX1002, ¶85.)

11. Claim 10

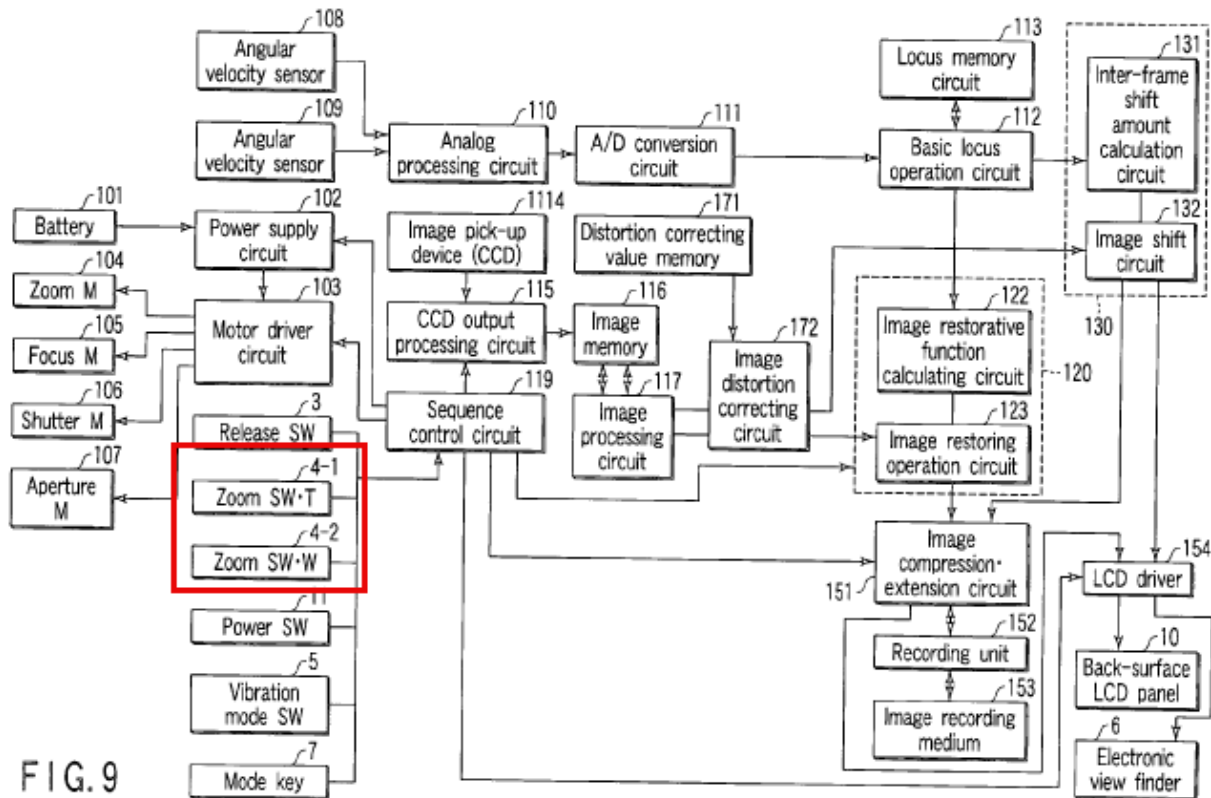
a. [Preamble] *The system of claim 9,*

Okubo meets the preamble as described above for claim 9. (EX1002, ¶86.)

b. [10A] *wherein the lens includes a wide angle lens, and*

Okubo meets this element. (EX1002, ¶87.) For example, as shown in FIG.

9, a zoom switch 4 includes a T button 4-1 and a W button 4-2:



(EX1004, [0068], [0106], FIG. 9 (annotated); EX1002, ¶87.)

Okubo explains that “when the W button is pressed, the magnification of the lens is changed to a wide side.” (EX1004, [0068]; EX1002, ¶88.) The POSITA would understand a lens that can be changed to a wide side to include a wide angle lens. (EX1002, ¶88.)

- c. **[10B] lens characteristics of the wide angle lens causes straight lines in the scene to appear as curved lines near edges of the input images.**

Okubo meets this element. (EX1002, ¶89.) For example, FIG. 11B of Okubo illustrates barrel-type lens distortion, in which straight lines of an object (shown in FIG. 11A) appear as curved lines near the edges of the input images as the result of wide angle lens characteristics. (EX1004, [0109]-[0110]; EX1002, ¶89.)

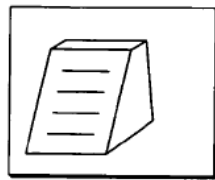


FIG. 11A

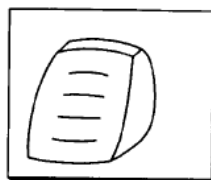


FIG. 11B

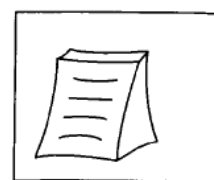


FIG. 11C

(EX1004, FIGS. 11A-11C; EX1002, ¶89.)

Additionally, FIGS. 11D and 11E illustrate that the lens distortion (*e.g.*, L_1 , L_2 , L_3) increases toward the edges of the input image (*e.g.*, as image height d increases from zero):

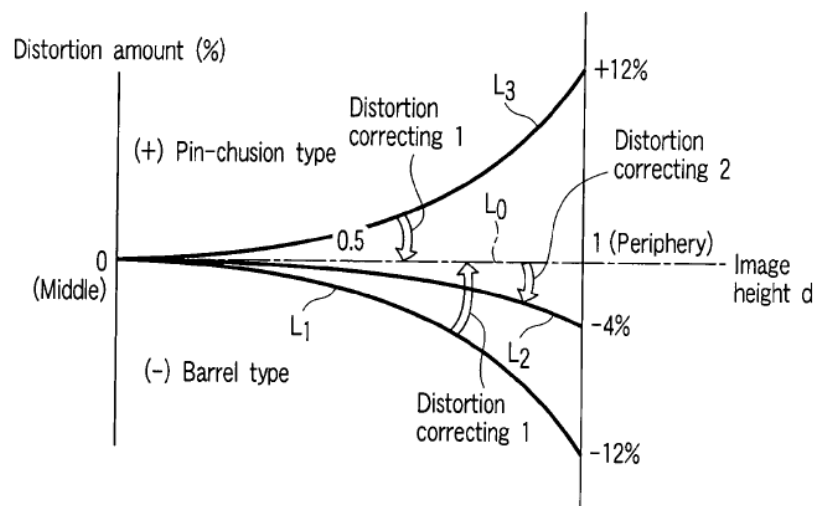
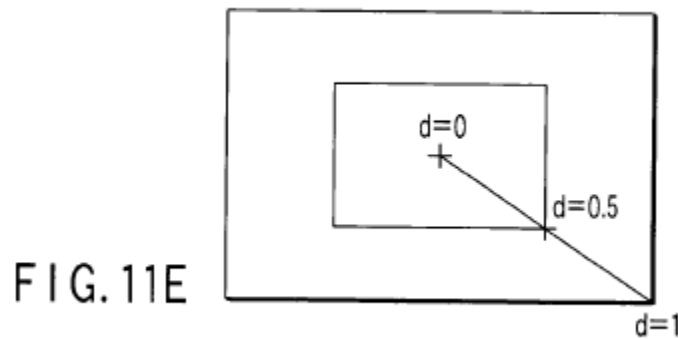


FIG. 11D



(EX1004, [0109]-[0111], FIG. 11D-11E; EX1002, ¶90.)

12. Claim 11

- a. **[Preamble]** *A method for simulating image distortion of a virtual lens in a video, the method comprising:*

Okubo meets the preamble as described above for claim 1. (EX1002, ¶91.)

- b. **[11A]** *accessing input images, the input images including fields of view of a scene captured through a lens of a camera, the input images depicting the scene with an input lens distortion centered in the fields of view;*

Okubo meets this element as described above for [1C]. (EX1002, ¶92.)

- c. **[11B]** *selecting sub-frames representing portions of the input images, the sub-frames including reduced fields of view of the scene smaller than the fields of view of the input images,*

Okubo meets this element as described above for [1D]. (EX1002, ¶93.)

- d. **[11C]** *the sub-frames including different lens distortion effects as a function of the input lens distortion present in the input images, different positions of areas of the input images included within the reduced fields of view, and a size of the areas of the input images included within the reduced fields of view; and*

Okubo meets this element as described above for [1E]. (EX1002, ¶94.)

- e. **[11D] *generating output images based on a desired lens distortion and the different lens distortion effects in the sub-frames, the desired lens distortion and the input lens distortion exhibiting consistent lens characteristics,***

Okubo meets this element as described above for [1F]. (EX1002, ¶95.)

- f. **[11E] *wherein the output images include the sub-frames remapped from the input lens distortion centered in the fields of view of the input images to the desired lens distortion centered in the reduced fields of view to transform the different lens distortion effects present in the sub-frames to the desired lens distortion such that portions of the scene depicted in the sub-frames appear to have been captured using the reduced fields of view.***

Okubo meets this element as described above for [1G]. (EX1002, ¶96.)

13. Claim 12

- a. **[Preamble] *The method of claim 11,***

Okubo meets the preamble as described above for claim 11. (EX1002, ¶97.)

- b. **[12A] *wherein image stabilization is applied to the input images.***

Okubo meets this element as described above for [2A]. (EX1002, ¶98.)

14. Claim 13

- a. **[Preamble] *The method of claim 11,***

Okubo meets the preamble as described above for claim 11. (EX1002, ¶99.)

- b. **[13A] *wherein the sub-frames are selected based on metadata associated with the input images.***

Okubo meets this element as described above for [3A]. (EX1002, ¶100.)

15. Claim 14

a. [Preamble] *The method of claim 13,*

Okubo meets the preamble as described above for claim 13. (EX1002, ¶101.)

b. [14A] *wherein the metadata indicates motion of the camera that captured the input images.*

Okubo meets this element as described above for [4A]. (EX1002, ¶102.)

16. Claim 15

a. [Preamble] *The method of claim 13,*

Okubo meets the preamble as described above for claim 13. (EX1002, ¶103.)

b. [15A] *wherein the metadata indicates orientation of the camera that captured the input images.*

Okubo meets this element as described above for [5A]. (EX1002, ¶104.)

17. Claim 16

a. [Preamble] *The method of claim 11,*

Okubo meets the preamble as described above for claim 11. (EX1002, ¶105.)

b. [16A] *wherein the output images are combined as video frames of an output video.*

Okubo meets this element as described above for [6A]. (EX1002, ¶106.)

18. Claim 17

a. [Preamble] *The method of claim 16,*

Okubo meets the preamble as described above for claim 16. (EX1002, ¶107.)

b. [17A] *wherein remapping of the sub-frames from the input lens distortion centered in the fields of view of the input images to the desired lens distortion centered in the reduced fields of view results in the output video having consistent frame-to-frame lens characteristics.*

Okubo meets this element as described above for [7A]. (EX1002, ¶108.)

19. Claim 18

a. [Preamble] *The method of claim 17,*

Okubo meets the preamble as described above for claim 17. (EX1002, ¶109.)

b. [18A] *wherein the different positions of the areas of the input images included within the reduced fields of view simulate virtual re-pointing of the camera using the reduced fields of view.*

Okubo meets this element as described above for [8A]. (EX1002, ¶110.)

20. Claim 19

a. [Preamble] *The method of claim 18,*

Okubo meets the preamble as described above for claim 18. (EX1002, ¶111.)

b. [19A] *wherein the method is performed by one or more processors included in the camera.*

Okubo meets this element as described above for [9A]. (EX1002, ¶112.)

21. Claim 20

a. [Preamble] *The method of claim 19,*

Okubo meets the preamble as described above for claim 19. (EX1002, ¶113.)

b. [20A] *wherein the lens includes a wide angle lens, and*

Okubo meets this element as described above for [10A]. (EX1002, ¶114.)

c. [20B] *lens characteristics of the wide angle lens causes straight lines in the scene to appear as curved lines near edges of the input images.*

Okubo meets this element as described above for [10B]. (EX1002, ¶115.)

B. Ground 2: Claims 1-20 Are Obvious Based On Okubo In View Of Sokeila

1. Summary of Sokeila

Sokeila is a U.S. Patent Application that was filed on April 16, 2013, and issued on March 31, 2015. Sokeila is thus prior art to the '052 patent under at least 35 U.S.C. §§ 102(a)(1) and (a)(2). Sokeila was not cited or considered during prosecution of the '052 patent.

Sokeila relates to cropping images in a digital video stabilization system using an adaptively predicted cropping factor. (EX1005, 1:22-46; EX1002, ¶118.) As Sokeila explains, it is desirable to minimize the extent to which a frame's field of view is reduced by cropping. (EX1005, 1:22-46; EX1002, ¶118.) Sokeila

discloses adaptively predicting a cropping factor, such as on a frame-by-frame-frame basis, by taking video data into consideration, thus reducing the extent to which frames are cropped unnecessarily. (EX1005, 1:22-46, 2:33-61; EX1002, ¶118.) For example, Sokeila discloses adjusting the cropping factor based on motion or a detected object of interest in an image, such as a face, and cropping non-centrally or non-symmetrically with respect to the image. (EX1005, 2:62-3:3, 3:30-41; EX1002, ¶118.)

Sokeila discloses that a camera includes an adaptive stabilization module 12, which can “predict, calculate, or estimate” cropping factors to be applied to video image frames that are stored in a ring buffer from the camera. (EX1005, 4:25-29, 6:25-42, FIGS. 1, 3; EX1002, ¶119.) FIG. 3 illustrates:

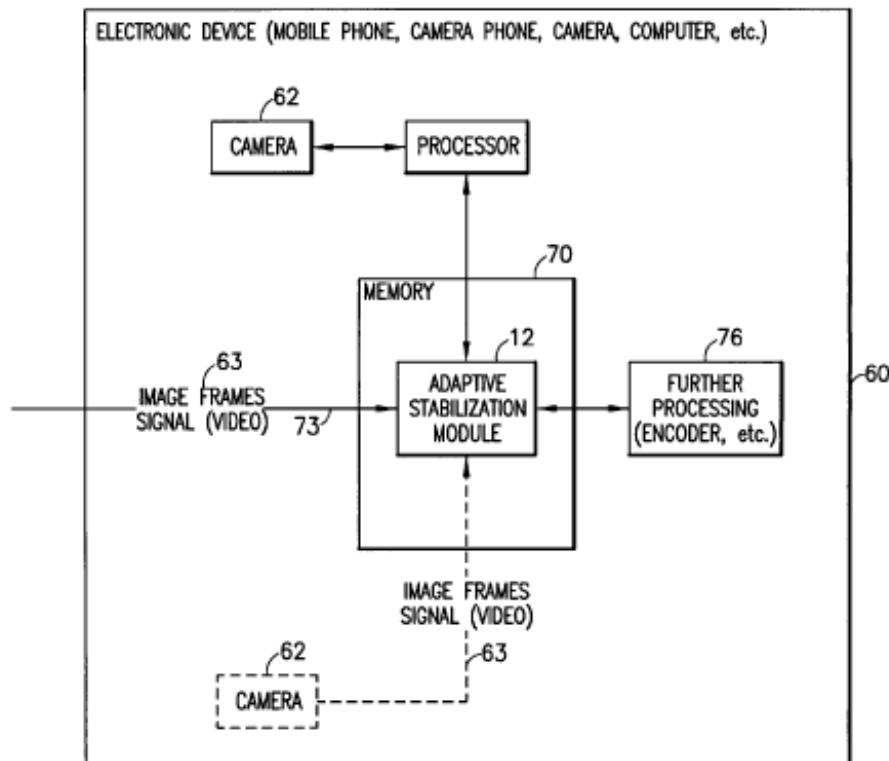


FIG.3

(EX1005, FIG. 3; EX1002, ¶119.)

2. Motivation to Combine Okubo and Sokeila with Reasonable Expectation of Success

A POSITA as of the 2015 priority date would have been motivated to combine Okubo and Sokeila to meet the claim limitations with a reasonable expectation of success. (EX1002, ¶120.)

First, Okubo and Sokeila both relate to a common problem of stabilizing video frames. (EX1004, [0005]; EX1005, 2:29-040; EX1002, ¶121.) Sokeila explains that when stabilizing an image, it is preferable to optimize the field of

view by avoiding cropping the frame more than is necessary: doing so can optimize video quality, enhance sharpness, and take up less memory storage space. (EX1005, 1:22-36, 3:42-47, 5:25-36; EX1002, ¶121.) Sokeila discloses achieving these benefits by “smoothly and intelligently” selecting adaptive cropping factors on a frame-by-frame basis; Sokeila’s techniques are thus advantageous over Okubo, which has fixed cropping factors that are based on metadata, such as described above in Section A.2.e. (EX1004, [0087]-[0091], FIG. 6B; EX1005, 2:41-61; EX1002, ¶121.) The POSITA would have been motivated to combine Sokeila with Okubo to realize the above specific technical advantages. (EX1002, ¶121.)

Second, Okubo discloses cropping sub-frames from an input CCD image, such as described above in Section A.2.e, but does not expressly teach how the sub-frames can be cropped, sized, or positioned based on the content of the image. (EX1002, ¶122.) The POSITA would thus have been motivated to look to Sokeila to understand how the sub-frames of Okubo could be beneficially sized and positioned with respect to the CCD image. (EX1002, ¶122.)

Third, Okubo and Sokeila use analogous electronic and optical components, such as cameras, processors, and data storage, in common and well-understood ways to implement solutions to the common problem of video stabilization. (EX1002, ¶123.) The POSITA’s combination of Okubo and Sokeila thus would

have yielded predictable results with a reasonable expectation of success.

(EX1002, ¶123.)

3. Claim 1

a. [Preamble]

Okubo in view of Sokeila meets the preamble for the reasons described in Section A.2.a. (EX1002, ¶124.)

b. [1A]

Okubo in view of Sokeila meets this element for the reasons described in Section A.2.b. (EX1002, ¶125.) Further, Sokeila discloses that the adaptive stabilization module can be implemented as a computer program executed by a processor. (EX1005, 6:60-7:4; EX1002, ¶125.)

c. [1B]

Okubo in view of Sokeila meets this element for the reasons described in Section A.2.c. (EX1002, ¶126.) Further, Sokeila discloses that the adaptive stabilization module can be implemented as a computer program stored in non-transitory computer readable memory 70. (EX1005, 6:60-7:4; EX1002, ¶126.)

d. [1C]

Okubo in view of Sokeila meets this element for the reasons described in Section A.2.d. (EX1002, ¶127.) Further, Sokeila discloses using a digital camera to receive (or capture) and access a plurality of image frames of a scene. (EX1005, 2:62-65, 5:51-61; EX1002, ¶127.)

e. [1D]

Okubo in view of Sokeila meets this element for the reasons described in Section A.2.e. (EX1002, ¶128.) Further, Sokeila discloses selecting sub-frames by cropping an input image using an adaptively determined cropping factor. (EX1005, 1:40-46; EX1002, ¶128.) For example, Sokeila discloses that a device such as a camera can perform a process described in FIG. 2:

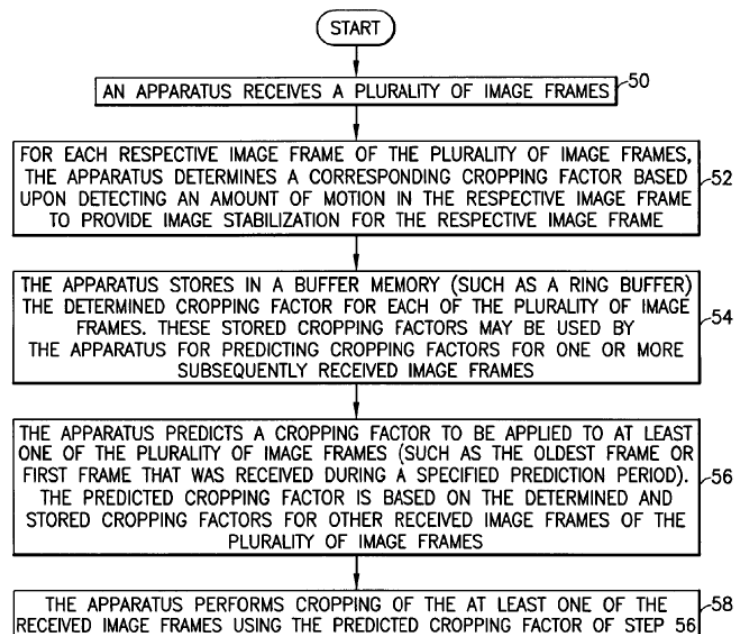


FIG.2

(EX1005, 5:37-50, FIG. 2; EX1002, ¶128.)

For example, at step 50 of the above process, the camera receives or captures a plurality of image frames from a camera. (EX1005, 5:51-55, FIG. 2; EX1002, ¶129.) At step 52, a cropping factor can be determined based on motion detected in the image frame; at step 56, a cropping factor can be predicted based on stored

cropping factors; and at step 58, at least one received image frame is cropped using the predicted cropping factor. (EX1005, 5:51-6:9, FIG. 2; EX1002, ¶129.) The cropping factors result in a reduced field of view compared to the input image, such as shown by the positive cropping factors indicated in Table 1 of Sokeila, indicating that the cropped sub-frames are smaller than the input image:

TABLE 1											
Cropping Factor Table											
	Frame Number										
	N	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10
Determined cropping for individual frames (as step 20 in FIG. 1)	1%	1%	1%	3%	1%	6%	6%	8%	2%	1%	1%
Predicted smooth cropping (step 24 in FIG. 1)	1%	2%	3%	4%	5%	6%	7%	8%	6%	4%	2%

(EX1005, 5:2-10, TABLE 1; EX1002, ¶129.)

f. [1E]

Okubo in view of Sokeila meets this element for the reasons described in Section A.2.f. (EX1002, ¶130.) Additionally, Sokeila discloses performing cropping “non-centrally or non-symmetrically with respect to one or more image boundaries,” so as to “avoid cropping an important subject” (such as a face or another object of interest) detected in the frame. (EX1005, 3:30-41; EX1002, ¶130.) The POSITA would understand this to disclose selecting sub-frames by cropping based on different positions of areas of the input images, at least because

the "important subject" may occupy different areas within the input images (*e.g.*, as a face or object of interest moves across the frame). (EX1002, ¶130.) In addition to the reasons described above for Section A.2.f, the sub-frames can include different lens distortion effects as a function of different positions or sizes of areas of the input images, for the additional reason that cropping based on differently centered or differently symmetric areas of the input images can result in the sub-frame including different distortion effects, analogous to the reasons described in Section A.2.f with respect to FIGs. 11D and 11E. (EX1002, ¶130.)

g. [1F]

Okubo in view of Sokeila meets this element for the reasons described in Section A.2.g. (EX1002, ¶131.)

h. [1G]

Okubo in view of Sokeila meets this element for the reasons described in Section A.2.h. (EX1002, ¶132.)

4. Claim 2

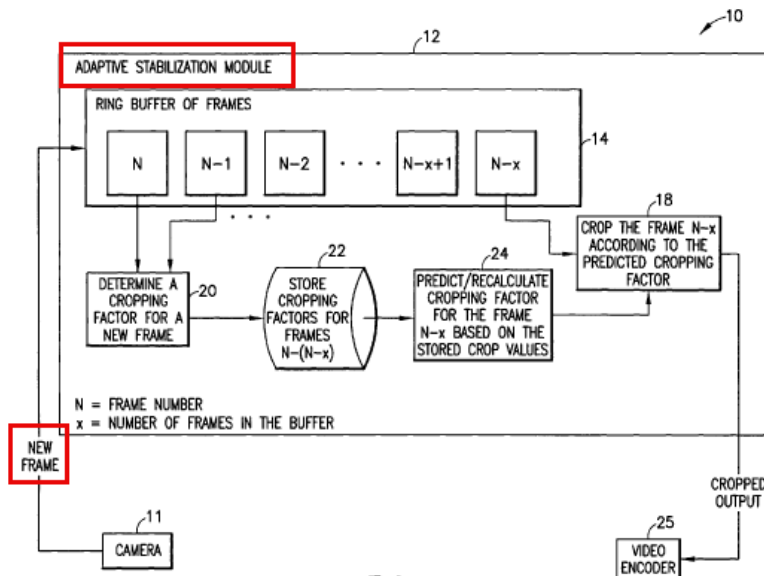
a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim 1. (EX1002, ¶133.)

b. [2A]

Okubo in view of Sokeila meets this element as described in Section A.3.b. (EX1002, ¶134.) Further, Sokeila's adaptive cropping is used for "video

stabilization.” (EX1005, 2:41-44; EX1002, ¶134.) In Sokeila, an adaptive stabilization module 12 can apply image stabilization to input images from camera 11, such as shown in FIG. 1:



(EX1005, 4:1-8, FIG. 1 (annotated); EX1002, ¶134.)

5. Claim 3

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

1. (EX1002, ¶135.)

b. [3A]

Okubo in view of Sokeila meets this element as described in Section A.4.b.

(EX1002, ¶136.) Further, Sokeila discloses selecting sub-frames using an adaptive cropping factor, such as described above for [1D]. (EX1002, ¶136.) The adaptive

cropping factor can be based on metadata for the input image, such as a detected amount of motion in an image; a detection of an object of interest, such as a face; or information from frame analysis or hardware sensor analysis. (EX1005, 2:62-3:12, 3:30-41; EX1002, ¶136.)

6. Claim 4

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim 3. (EX1002, ¶137.)

b. [4A]

Okubo in view of Sokeila meets this element as described in Section A.5.b. (EX1002, ¶138.) Further, Sokeila discloses selecting sub-frames using an adaptive cropping factor, such as described above for [1D]. (EX1002, ¶138.) The adaptive cropping factor can be based on a detected amount of motion for a video frame. (EX1005, 2:62-3:12; EX1002, ¶138.)

7. Claim 5

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim 3. (EX1002, ¶139.)

b. [5A]

Okubo in view of Sokeila meets this element as described in Section A.6.b. (EX1002, ¶140.) Further, Sokeila discloses that the metadata indicates an

orientation of the camera. (EX1002, ¶140.) For example, “if a face is detected and the image frame only requires horizontal stabilization, a vertical crop only of the image frame could be implemented.” (EX1005, 3:30-41; EX1002, ¶140.) To the extent not expressly disclosed in Sokeila, it would have been obvious to the POSITA that metadata (*e.g.*, face detection data) indicating whether only horizontal stabilization is needed indicates an orientation of the camera (*e.g.*, with respect to the horizontal). (EX1002, ¶140.)

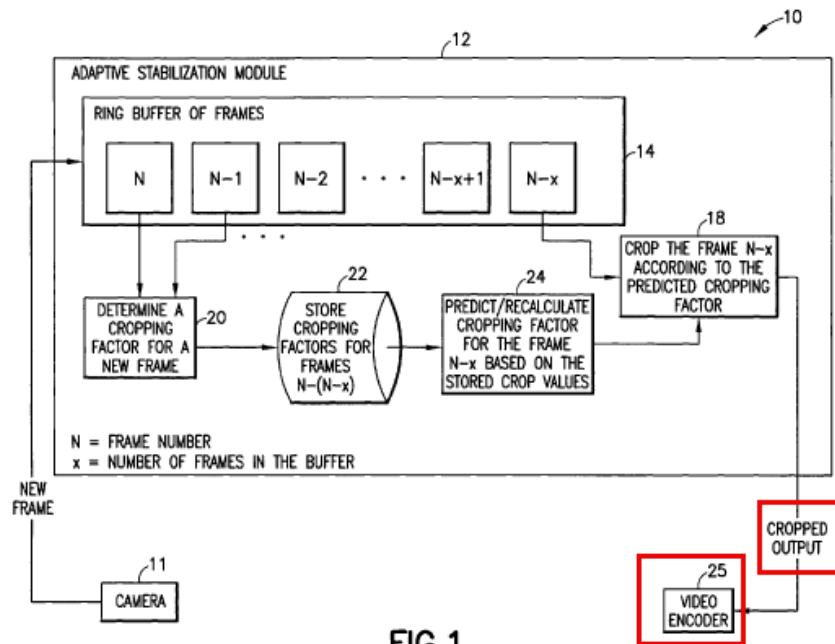
8. Claim 6

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim 1. (EX1002, ¶141.)

b. [6A]

Okubo in view of Sokeila meets this element as described in Section A.7.b. (EX1002, ¶142.) Further, Sokeila’s cropped output frames of the adaptive stabilization module 12 are provided to a video encoder 25, such as shown in FIG. 1, which the POSITA would understand to disclose combining the output frames into a video using the video encoder:



(EX1005, 4:1-7, FIG. 1 (annotated); EX1002, ¶142.)

9. Claim 7

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

6. (EX1002, ¶143.)

b. [7A]

Okubo in view of Sokeila meets this element for the reasons described in Section A.8.b. (EX1002, ¶144.) Further, Sokeila discloses that “an optimal cropping factor or a minimized cropping factor may be used based on the future prediction to make the cropping factor change smoothly over time,” which the POSITA would understand to result in consistent frame-to-frame lens

characteristics. (EX1005, 2:41-61; EX1002, ¶144.)

10. Claim 8

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim 7. (EX1002, ¶145.)

b. [8A]

Okubo in view of Sokeila meets this element as described in Section A.9.b. (EX1002, ¶146.) Further, Sokeila discloses detecting an object of interest (*e.g.*, a face) within a video frame, and performing cropping “non-centrally or non-symmetrically with respect to one or more image boundaries,” so as to “avoid cropping an important subject” detected in the frame. (EX1005, 3:30-41; EX1002, ¶146.) The POSITA would understand cropping non-centrally or non-symmetrically with respect to the image to meet the claimed virtual re-pointing, at least because cropping an image non-centrally will have the effect of re-centering (re-pointing) the cropped image with respect to the input image. (EX1002, ¶146.)

11. Claim 9

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim 8. (EX1002, ¶147.)

b. [9A]

Okubo in view of Sokeila meets this element as described in Section A.10.b.

(EX1002, ¶148.) Further, Sokeila discloses that a processor and memory can be included in an electronic device that is a camera, as illustrated in FIG. 3:

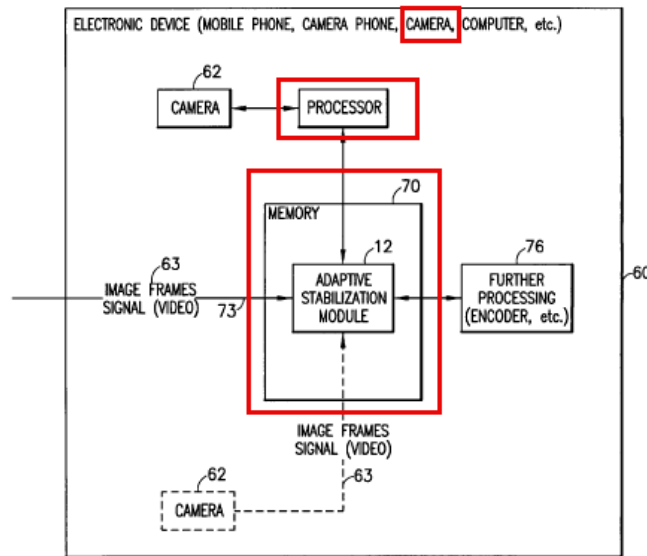


FIG.3

(EX1005, FIG. 3 (annotated); EX1002, ¶148.)

12. Claim 10

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

9. (EX1002, ¶149.)

b. [10A]

Okubo in view of Sokeila meets this element as described in Section A.11.b.

(EX1002, ¶150.) Further, Sokeila is directed to solving a problem (unnecessarily reduced field of view) that is “especially problematic in wide angle applications.”

(EX1005, 1:26-30; EX1002, ¶150.)

c. [10B]

Okubo in view of Sokeila meets this element as described in Section A.11.c.

(EX1002, ¶151.)

13. Claim 11**a. [Preamble]**

Okubo in view of Sokeila meets the preamble as described above for claim

1. (EX1002, ¶152.)

b. [11A]

Okubo in view of Sokeila meets this element as described above for [1C].

(EX1002, ¶153.)

c. [11B]

Okubo in view of Sokeila meets this element as described above for [1D].

(EX1002, ¶154.)

d. [11C]

Okubo in view of Sokeila meets this element as described above for [1E].

(EX1002, ¶155.)

e. [11D]

Okubo in view of Sokeila meets this element as described above for [1F].

(EX1002, ¶156.)

f. [11E]

Okubo in view of Sokeila meets this element as described above for [1G].

(EX1002, ¶157.)

14. Claim 12

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

11. (EX1002, ¶158.)

b. [12A]

Okubo in view of Sokeila meets this element as described above for [2A].

(EX1002, ¶159.)

15. Claim 13

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

11. (EX1002, ¶160.)

b. [13A]

Okubo in view of Sokeila meets this element as described above for [3A].

(EX1002, ¶161.)

16. Claim 14

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

13. (EX1002, ¶162.)

b. [14A]

Okubo in view of Sokeila meets this element as described above for [4A].

(EX1002, ¶163.)

17. Claim 15

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

13. (EX1002, ¶164.)

b. [15A]

Okubo in view of Sokeila meets this element as described above for [5A].

(EX1002, ¶165.)

18. Claim 16

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

11. (EX1002, ¶166.)

b. [16A]

Okubo in view of Sokeila meets this element as described above for [6A].

(EX1002, ¶167.)

19. Claim 17

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

16. (EX1002, ¶168.)

b. [17A]

Okubo in view of Sokeila meets this element as described above for [7A].

(EX1002, ¶169.)

20. Claim 18

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

17. (EX1002, ¶170.)

b. [18A]

Okubo in view of Sokeila meets this element as described above for [8A].

(EX1002, ¶171.)

21. Claim 19

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

18. (EX1002, ¶172.)

b. [19A]

Okubo in view of Sokeila meets this element as described above for [9A].

(EX1002, ¶173.)

22. Claim 20

a. [Preamble]

Okubo in view of Sokeila meets the preamble as described above for claim

19. (EX1002, ¶174.)

b. [20A]

Okubo in view of Sokeila meets this element as described above for [10A].

(EX1002, ¶175.)

c. [20B]

Okubo in view of Sokeila meets this element as described above for [10B].

(EX1002, ¶176.)

C. Ground 3: Claims 1-20 Are Obvious Based On Eder

1. Summary of Eder

Eder is a U.S. Patent Application that was filed on April 19, 2011, published on October 20, 2011, and issued on January 19, 2016. (EX1009.) Eder is thus prior art to the '052 patent under at least 35 U.S.C. §§ 102(a)(1) and (a)(2). Eder was not cited or considered during prosecution of the '052 patent.

Eder discloses a rear view image improvement system for a vehicle. (EX1009, 1:51-56; EX1002, ¶179.) An image corresponding to an exterior rear-facing side mirror of the vehicle is captured by a camera with a wide-angle lens, modified, and then presented to the driver using a display device. (EX1009, 1:15-18, 1:36-50, 4:3-7, Fig. 5; EX1002, ¶179.) In embodiments, the exterior mirror may be included or replaced with a camera system that provides the same field of view. (EX1009, 2:42-49; EX1002, ¶179.) Figs. 4 and 5 show examples of a vehicle 8 with camera 6 and display device 20 for driver 9:

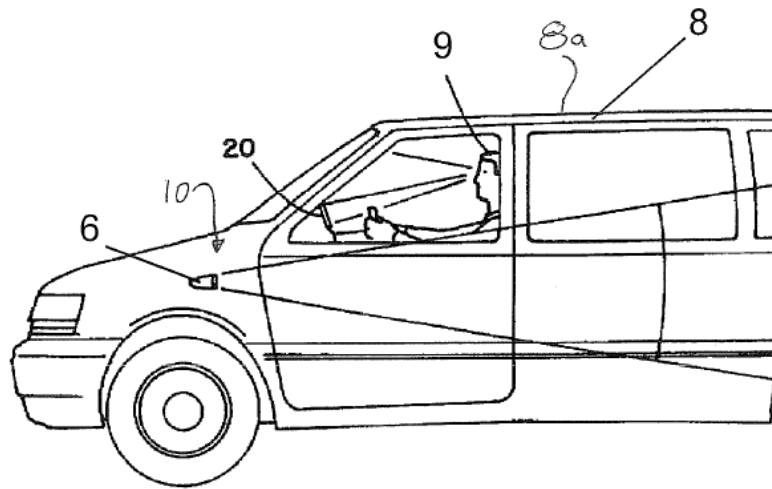


Fig. 4

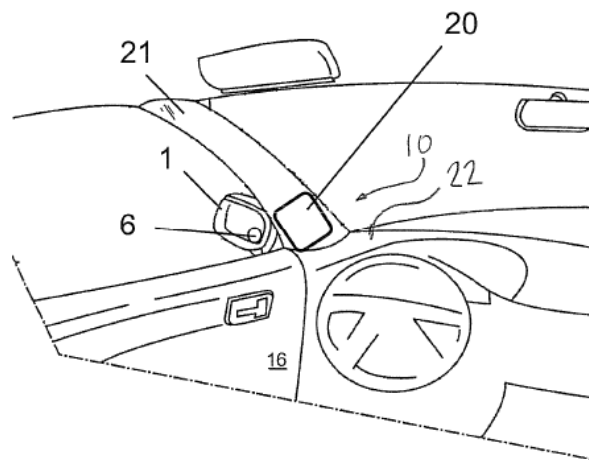


Fig. 5

(EX1009, 2:60-3:33, Figs. 4, 5; EX1002, ¶179.)

The captured images are modified to simulate the lens distortion that the driver would expect to see in the mirror. (EX1009, 1:36-62, 4:3-7; EX1002, ¶180.)

Fig. 6 illustrates an example process, in which an image is recorded (60), rectified (63), distorted (65), and displayed to the driver (20):

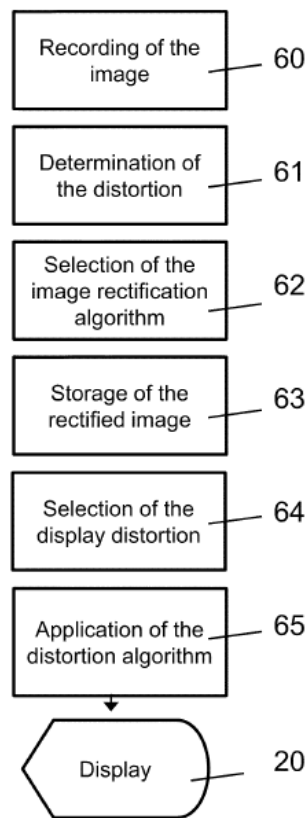


Fig. 6

(EX1009, 4:3-5:67, Fig. 6; EX1002, ¶180.)

2. Claim 1

a. [Preamble]

Eder meets the preamble. (EX1002, ¶181.) For example, Eder discloses an “exterior mirror simulation” with image data recording and a device for displaying the data for the driver of a vehicle. (EX1009, 1:9-11; EX1002, ¶181.) The images are transmitted by video data to the display device. (EX1009, 3:67-4:2; EX1002, ¶181.) The image of a wide-angle camera is distorted, and post-distortion is applied to the image, “in order to give this image the same view as that of the

desired mirror glass.” (EX1009, 4:3-7; EX1002, ¶181.)

b. [1A]

Eder meets this element. (EX1002, ¶182.) For example, the vehicle includes a “computation unit” with “processing capacities.” The computation unit can include, *e.g.*, a DSP, an FPGA, a microprocessor, an ASIC, or a combination thereof. (EX1009, 3:48-58; EX1002, ¶182.)

c. [1B]

Eder meets this element. (EX1002, ¶183.) For example, the computation unit is programmable; for instance, a computer-readable medium can include read only memory (ROM) or binary image data that can be programmed by a user. (EX1009, 3:48-58; EX1002, ¶183.)

d. [1C]

Eder meets this element. (EX1002, ¶184.) For example, “real-time wide-angle video images” are captured and converted to electrical signals by a camera 6, illustrated in Fig. 3:

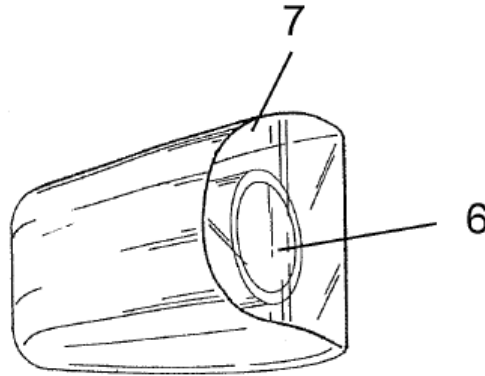


Fig. 3

(EX1009, 3:14-20, Fig. 3; EX1002, ¶184.)

The camera 6 captures input images including a field of view of a scene (*e.g.*, a scene facing rearwards from the vehicle 8). (EX1009, 3:34-37, 4:3-7; EX1002, ¶185.) The camera 6 includes a “wide angle lens” that imparts a perspective effect and a visual distortion (*e.g.*, barrel distortion). (EX1009, 4:14-31, 6:16; EX1002, ¶185.) The POSITA would understand that this input lens distortion may be centered in the field of view, at least because such distortion is illustrated in Fig. 8 as centered in the field of view:

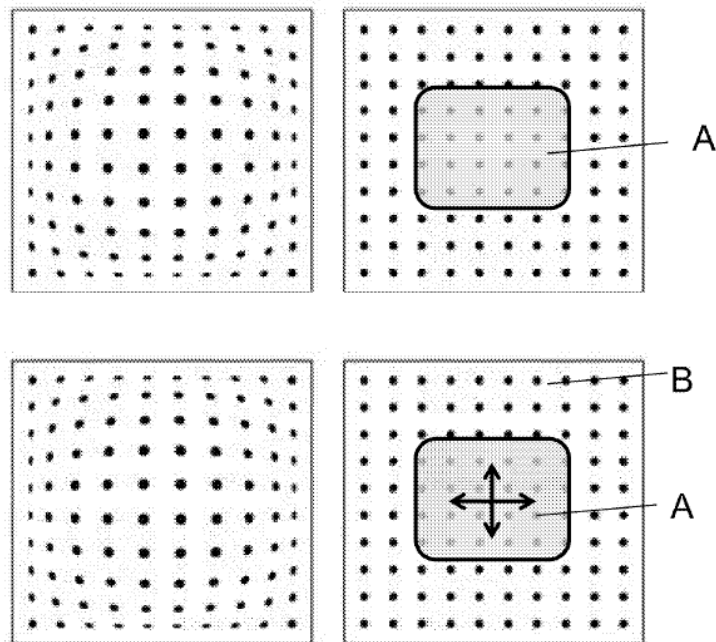


Fig. 8

(EX1009, 2:10, 4:64-5:34, Fig. 8; EX1002, ¶185.)

e. [1D]

Eder meets this element. (EX1002, ¶186.) For example, Eder discloses applying an image rectification algorithm to a “subset of the total pixels in the image to create a rectified image.” (EX1009, 6:19-20, 8:3-4, *see also* 6:39-41, 8:21-23; EX1002, ¶186.) As the POSITA would recognize, a subset of the total pixels of an input image represents a portion of that input image, at least because, as a general matter, a subset of a group of pixels represents a portion of that group of pixels. (EX1002, ¶186.) For instance, as annotated below with respect to Fig. 8, area A represents a subset, and thus a portion, of the total pixels B of the input

image:

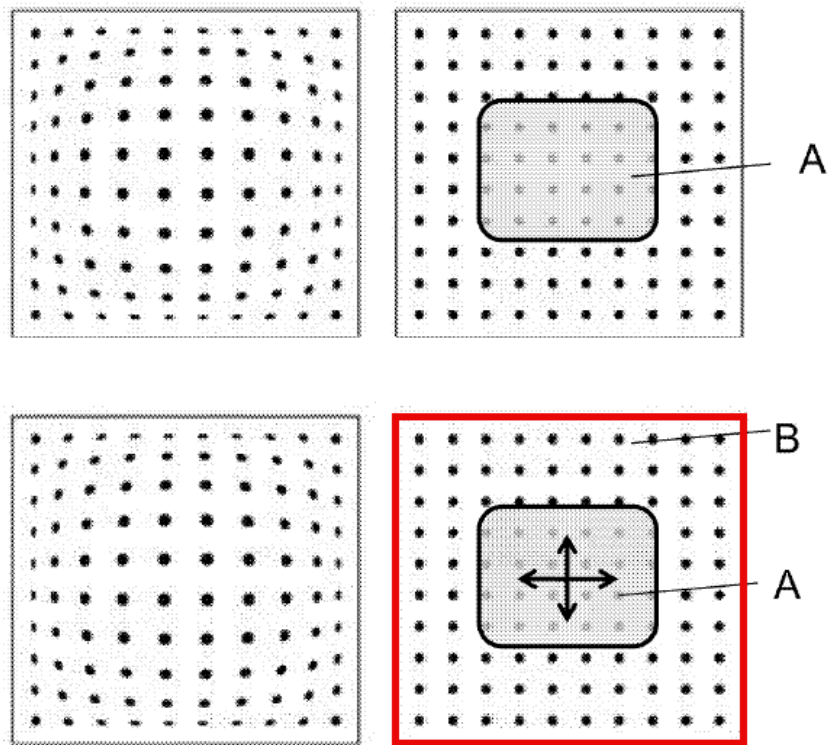


Fig. 8

(EX1009, 2:10, 5:4-16, Fig. 8 (annotated); EX1002, ¶186.)

Similarly, the POSITA would recognize that the subset of the total pixels of an input image includes a reduced field of view of the scene depicted in that image, smaller than the fields of view of the input image. (EX1002, ¶187.) For instance, Eder’s camera captures “real-time wide-angle video images” that include a field of view of a scene, as described above for [1C]. (EX1009, 3:14-20, 3:34-37, 4:3-7; EX1002, ¶187.) The POSITA would recognize based on experience with image and video processing that a subset of the total pixels that represent such wide-angle

video images will include a smaller field of view of the scene than the field of view depicted by the total pixels, for at least the reasons described above with respect to Fig. 8. (EX1002, ¶187.) This is true even if the input image is viewed to also include a larger field of view (*e.g.*, via wide angle additional lens 5, described below), at least because the claim requires only that the subset “includes” the reduced field of view and is not limited to providing only the reduced field of view. (EX1002, ¶187.)

Additionally, Eder discloses selecting sub-frames representing portions of the input images at least by “adapting the field of view to the driver’s position.” (EX1009, 5:26-5:34, Fig. 8; EX1002, ¶188.) For example, Eder discloses (with respect to Fig. 8, above) that a “mirror adjustment” can be performed by “moving section A on the optical sensor, so that other pixels of the optical sensors are visualized.” (EX1009, 5:26-5:34, Fig. 8; EX1002, ¶188.)

f. [1E]

Eder meets this element. (EX1002, ¶189.) For example, Eder discloses applying optical distortion correction to the sub-frames of the input images as part of an image rectification process. (EX1009, 4:3-25, 6:19-20, 8:3-4; EX1002, ¶189.) For instance, claims 1 and 12 of Eder recite “applying the image rectification algorithm to subset of the total pixels in the image to create a rectified image”. (EX1009, 6:19-20, 8:3-4; EX1002, ¶189.)

The sub-frames include different lens distortion effects as a function of the input lens distortion present in the input images. (EX1002, ¶190.) For example, the optical distortion correction of the image rectification process “facilitates the removal of a perspective effect and a visual distortion, which is caused by a wide angle lens used in the camera 6.” (EX1009, 4:15-18; EX1002, ¶190.) The optical distortion correction uses a mathematical model of the distortion to determine the correct position of the pixels, which are recorded in the input images. (EX1009, 4:18-25; EX1002, ¶190.) For example, distortion co-efficient values k_1 and k_2 can be used to eliminate various distortion effects (*e.g.*, barrel distortion) created by the use of a wide angle lens. (EX1009, 4:26-31; EX1002, ¶190.) Different distortion effects in the sub-frame can also be provided by the inclusion of additional mirror 5, which may be a convex lens, such as described below. (EX1009, 2:23-31; EX1002, ¶190.)

The lens distortion effects are also a function of different positions of areas of the input images included within the reduced fields of view. (EX1002, ¶191.) For example, lines on one side of an input image (*i.e.*, a first position of area of the input image) may be barrel distorted, and lines on the other side of the image (*i.e.*, a second position of area of the input image) may be pin-cushion distorted. (EX1009, 4:40-50; EX1002, ¶191.) Thus, as the POSITA would recognize, different lens distortion effects (*e.g.*, barrel distortion or pin-cushion distortion) are

present in the images as a function of the sub-frame's position within the input image (*e.g.*, on “one side” of the image or on the “other side” of the image).

(EX1002, ¶191.)

Similarly, the lens distortion effects are also a function of a size of the areas of the input images included within the reduced fields of view. (EX1002, ¶192.)

This is at least because, as the POSITA would recognize, the size of the input images included within the sub-frames' reduced fields of view determines the degree to which such lens distortion effects in the input image (*e.g.*, barrel distortion or pin-cushion distortion) are included within the sub-frames. (EX1002, ¶192.) For instance, as described above, such lens distortion effects may be present on the sides of the image, such that they are included in larger sub-frames that approach the sides of the image. (EX1009, 4:40-50; EX1002, ¶192.)

g. [1F]

Eder meets this element. (EX1002, ¶193.) For example, Eder discloses that continuous input images are modified and are output to the display device as video data. (EX1009, 3:34-41; EX1002, ¶193.) Fig. 6 illustrates an example process:

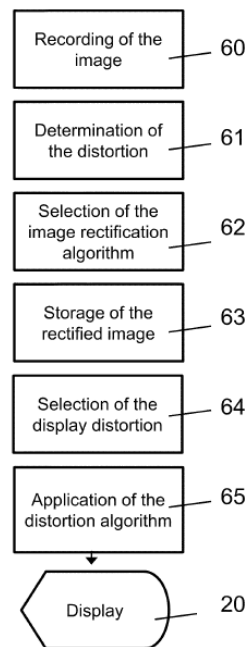


Fig. 6

(EX1009, 4:3-50, Fig. 6; EX1002, ¶193.)

The input images are modified by an image rectification process (62, 63), such as described above. (EX1009, 4:3-50, Fig. 6; EX1002, ¶194.) The image rectification process results in “low-error image[s].” (EX1009, 4:51-52; EX1002, ¶194.) The low-error images, from which the output images are generated (*e.g.*, stages 63-65) are based on the different lens distortion effects in the sub-frames as described above for [1E]. (EX1002, ¶194.) For example, the image rectification process modifies the input images based on characteristics of the lens distortion effects, such as by using distortion co-efficient values k_1 and k_2 for real-time image correction. (EX1009, 4:26-50; EX1002, ¶194.)

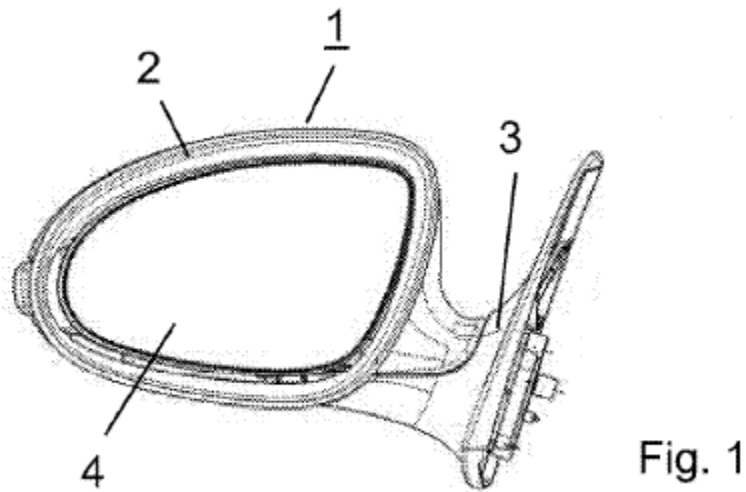
At stages 64 and 65, post-distortion is applied to the low-error images, “in

order to give this image the same view as that of the desired mirror glass.”

(EX1009, 4:3-7, 4:64-5:16; EX1002, ¶195.) Applying the post-distortion process meets the claimed desired lens distortion at least by imparting the distortion of the desired mirror glass, in order to give the images the same view as the desired mirror glass. (EX1009, 4:3-7; EX1002, ¶195.)⁴

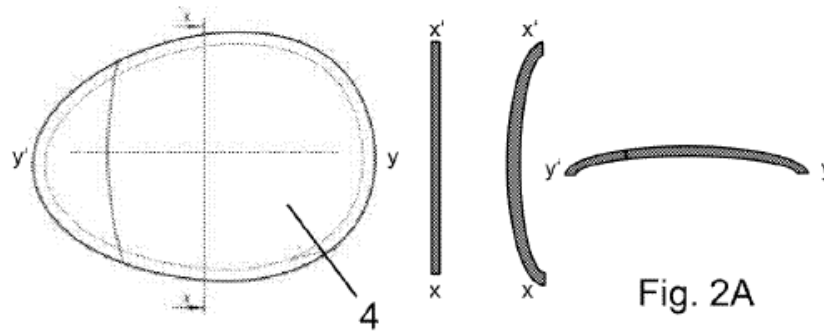
In some embodiments, the vehicle can include an exterior mirror configured for mirror glass 4; however, in some embodiments, the exterior mirror can be replaced with a camera system that provides the same field of view. (EX1009, 2:14-17, 2:42-49; EX1002, ¶196.) Fig. 1 illustrates an example exterior mirror:

⁴ The POSITA would understand Eder’s mirror glass distortion to meet the claimed lens distortion, at least because mirrors and lenses are analogous optical structures with analogous geometry that can exhibit analogous distortion properties, and based further on the POSITA’s experience with image and video processing. (EX1010, 42; EX1002, ¶195 note 1.) For example, Eder discloses that additional mirror 5 can be provided “in the form of a convex additional lens.” (EX1009, 2:23-26; EX1002, ¶195 note 1.) The claimed desired lens distortion is thus met at least by the distortion properties of the additional mirror 5. (EX1002, ¶195 note 1.)



(EX1009, 2:14-17, Fig. 1; EX1002, ¶196.)

Eder discloses that a desired mirror glass 4 can include flat plane glass, or a mirror glass with a curvature radius, such as shown in Fig. 2A:



(EX1009, 2:32-37, Fig. 2A; EX1002, ¶197.)

Mirror glass 4 can also include convex mirror glass; and/or glass with an aspherical component. (EX1009, 2:35-37; EX1002, ¶198.) Further, mirror glass 4 can also include an additional mirror 5, also referred to as a spot mirror or a blind spot mirror, which may be a convex additional lens used on the front or rear side of

the mirror glass 4, as shown in Fig. 2B:

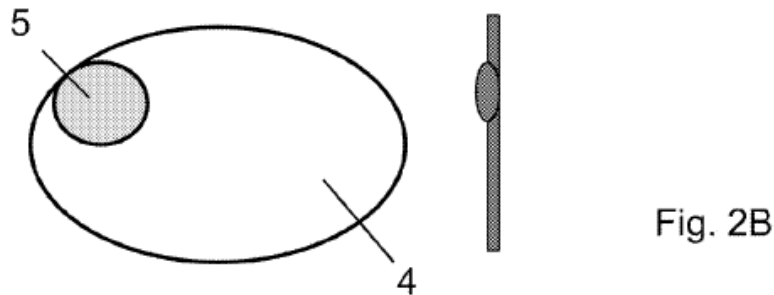


Fig. 2B

(EX1009, 2:18-31, Fig. 2B; EX1002, ¶198.)

The post-distortion stages 64, 65 generate the output images based on a desired mirror glass such as shown above. (EX1002, ¶199.) For example, at stage 64, an algorithm can be selected in order to distort the low-error image “as would be shown in mirror glass with an aspheric curve,” *e.g.*, by moving pixel values to “obtain the impression of curved mirror glass.” (EX1009, 4:64-5:3; EX1002, ¶199.) The post-distortion can be carried out at stage 65, such as by applying a transformation to the image pixels to distort the pixels appropriately and optimally display the resulting image. (EX1009, 5:4-21; EX1002, ¶199.)

The desired lens distortion (*e.g.*, distortion of the desired mirror glass) and the input lens distortion (*e.g.*, barrel distortion or pin-cushion distortion of a wide angle lens) exhibit consistent lens characteristics at least in that the camera system can provide the same field of view as the exterior mirror. (EX1009, 2:42-49; EX1002, ¶200.) To the extent the claim requires that the desired lens distortion

and the input lens distortion exhibit distortion characteristics of the lens of the camera, this is met at least because Eder discloses that the desired lens distortion may be that of a wide angle additional lens 5, thus exhibiting distortion characteristics of the wide angle lens of the camera 6. (EX1009, 2:23-31; EX1002, ¶200.)

h. [1G]

Eder meets this element. (EX1002, ¶201.) In Eder, the sub-frames are remapped from the input lens distortion to the desired lens distortion. (EX1002, ¶201.) For example, as described above for [1F], Eder discloses applying a rectification process 62, 63 to sub-frames of input images, to produce a low-error image based on different lens distortion effects in those sub-frames. (EX1009, 4:3-7, 4:64-5:16; EX1002, ¶201.) This is performed by applying a mathematical model of the input lens distortion that corrects, or remaps, the pixel position of the continuous images, such as described above. (EX1009, 4:14-25; EX1002, ¶201.)

In stage 65 of the example process shown in Fig. 6, a post-distortion process is then applied to the low-error image in order to give the image “the same view as that of the desired mirror glass.” (EX1009, 4:3-7; EX1002, ¶202.) For example, an algorithm is applied by which “the pixel values must be moved in a certain area in order to obtain the impression of curved mirror glass.” (EX1009, 4:64-5:3; EX1002, ¶202.) The sub-frames are thus remapped from the input lens distortion

to the desired lens distortion at least by the rectification process (62, 63) followed by the post-distortion process (65). This is analogous to the “two-step transformation” described in the ’052 patent, in which a first step is performed to “remove the lens distortion present in the sub-frame,” and a second step is then performed to “re-introduce a lens distortion effect.” (EX1001, 12:25-42; EX1002, ¶202.)

By giving the low-error image the same view as the desired mirror glass, and obtaining the impression of the desired mirror glass (*e.g.*, curved mirror glass), Eder transforms the lens distortion effects of the sub-frames to the desired lens distortion, such that portions of the scene in the sub-frames appear to have been captured using the reduced fields of view. (EX1002, ¶203.)

As an example, Eder discloses that a larger field of view can be provided when the vehicle is in reverse, and a smaller field of view can be provided when the vehicle is in forward drive. (EX1009, 5:26-49; EX1002, ¶204.) Fig. 7, which illustrates an “alternative process” to Fig. 6, illustrates:

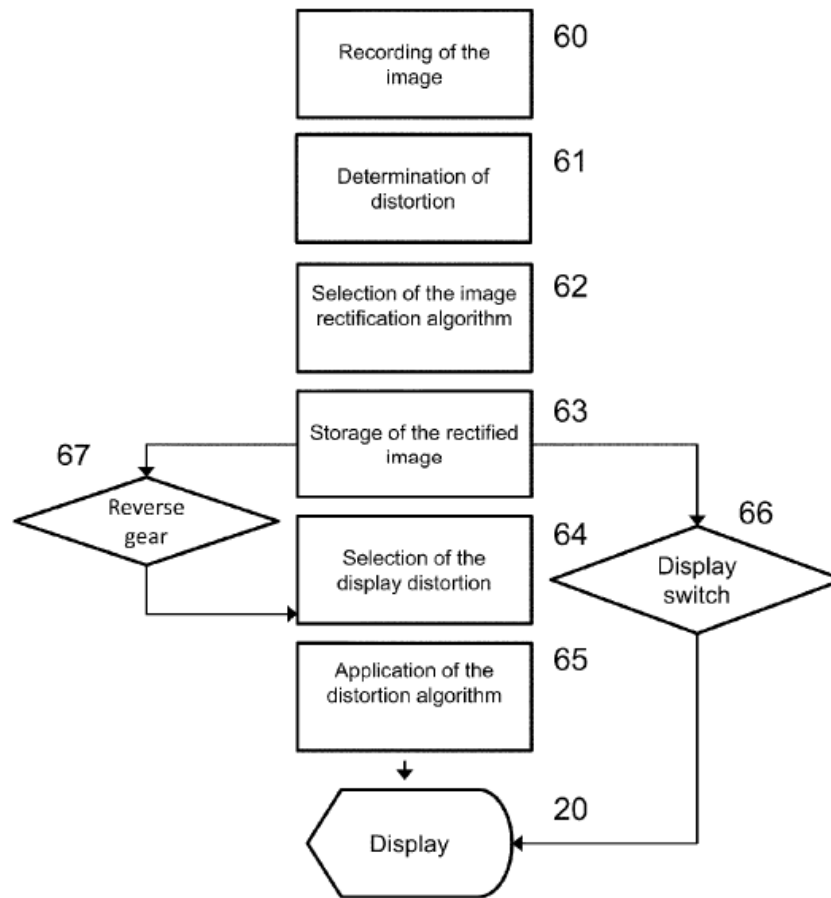


Fig. 7

(EX1009, 2:10, 5:26-49, Fig. 7; EX1002, ¶204.)

For instance, a selector switch 67 indicates whether the vehicle is in reverse or in forward drive, and the sub-frames present the larger field of view (“enlarged rear view”) or the smaller field of view (*e.g.*, the “predetermined display mode”) accordingly, such that the portions of the scene depicted in the sub-frames (*e.g.*, the enlarged rear view or predetermined display mode) appear to have been captured using their respective reduced fields of view. (EX1009, 2:10, 5:26-49, Fig. 7;

EX1002, ¶205.)

3. Claim 2

a. [Preamble]

Eder meets the preamble as described above for claim 1. (EX1002, ¶206.)

b. [2A]

Eder meets this element. (EX1002, ¶207.) Eder discloses optical distortion correction in which the “correct position of the pixels” is determined, and the “pixel position of the continuous images” is corrected. (EX1009, 4:18-25; EX1002, ¶207.) For example, the image rectification process (63), which is applied to input images before generating output images, as described above, can use a part of the vehicle as a reference to determine the correct position of the pixels. (EX1009, 3:37-41; EX1002, ¶207.) The POSITA would understand this process to meet the claimed image stabilization at least because correcting the positions of pixels in a series of continuous images can exhibit the effect of stabilizing those images. (EX1002, ¶207.)

Furthermore, to the extent not expressly disclosed in Eder, it would have been obvious to the POSITA to utilize Eder’s image rectification process, which corrects the pixel positions as described above, to stabilize the images. (EX1002, ¶208.) This is at least because doing so would apply techniques expressly described in Eder to improve vehicle safety, by enabling a driver to easily focus on

and understand rear mirror images; would advance Eder's goals of improving the images presented on a conventional rear view mirror, and improving the driver's ability to identify dangers. (EX1009, 1:51-62, 2:23-28; EX1002, ¶208.)

4. Claim 3

a. [Preamble]

Eder meets the preamble as described above for claim 1. (EX1002, ¶209.)

b. [3A]

Eder meets this element. (EX1002, ¶210.) For example, the sub-frames are selected based on metadata associated with the input images (*e.g.*, reverse gear, forward gear). (EX1009, 5:39-49; EX1002, ¶210.) For instance, selector switch 67 provides metadata indicating whether the vehicle is in forward or reverse gear; and that metadata is used to select a "larger field of view" if the metadata indicates the vehicle is in reverse gear. (EX1009, 5:39-49; EX1002, ¶210.) Conversely, a smaller field of view is selected if the metadata indicates the vehicle is in forward gear. (EX1009, 5:39-49; EX1002, ¶210.) Fig. 7 illustrates the selector switch 67:

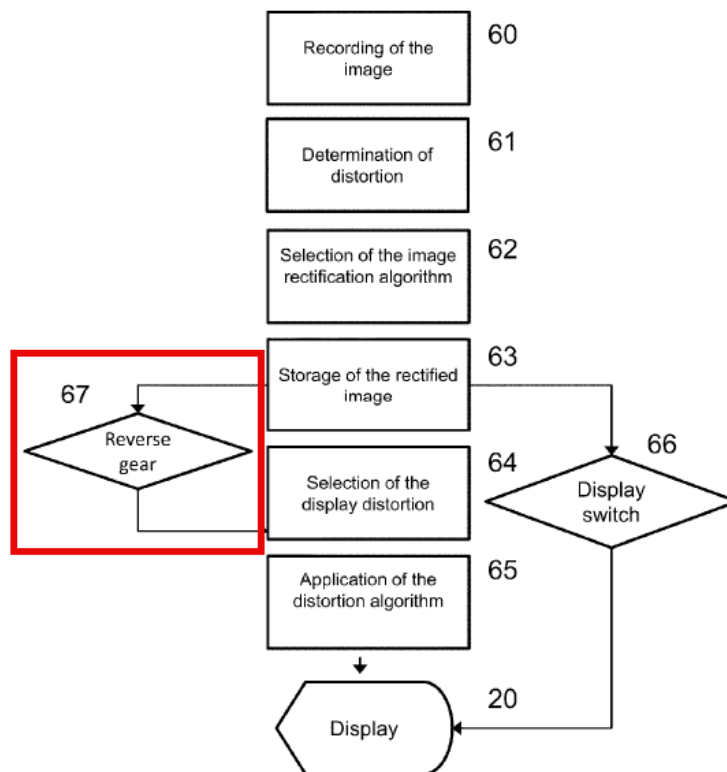


Fig. 7

(EX1009, Fig. 7 (annotated); EX1002, ¶210.)

5. Claim 4

a. [Preamble]

Eder meets the preamble as described above for claim 3. (EX1002, ¶211.)

b. [4A]

Eder meets this element as described above for [3A]. (EX1002, ¶212.) For example, the selector switch 67 indicates whether the vehicle (and thus camera 6, *see* EX1009 Figs. 4, 5) is in forward motion or reverse motion. (EX1009, 5:39-49; EX1002, ¶212.)

6. Claim 5**a. [Preamble]**

Eder meets the preamble as described above for claim 3. (EX1002, ¶213.)

b. [5A]

Eder meets this element. (EX1002, ¶214.) For example, distortion coefficient values k_1 and k_2 , as described above for claim 1, can be adjusted or coordinated based on known straight lines recorded in an image. (EX1009, 4:32-50; EX1002, ¶214.) For instance, the distortion center can be registered based on “the straightest horizontal and vertical lines, such that the distortion center from which sub-frames may be selected is situated where the two lines intersect. (EX1009, 4:32-50; EX1002, ¶214.) As the POSITA would recognize, based on the POSITA’s experience with image and video processing, lines known to be horizontal and vertical lines in the input images meet metadata indicating the orientation of the camera that captured the images, at least because such lines indicate the orientation of the camera relative to a horizontal or vertical axis. (EX1009, 4:32-50; EX1002, ¶214.)

7. Claim 6**a. [Preamble]**

Eder meets the preamble as described above for claim 1. (EX1002, ¶215.)

b. [6A]

Eder meets this element. (EX1002, ¶216.) For example, the output images

are combined as video frames of an output video, at least by the rear view assembly 10 “deliver[ing] real-time wide-angle video images to the driver 9”. (EX1009, 3:10-15; EX1002, ¶216.) For instance, Eder’s image rectification module “modifies the continuous images, which are transmitted to the display device 20 as video data.” (EX1009, 3:37-41; EX1002, ¶216.)

8. Claim 7

a. [Preamble]

Eder meets the preamble as described above for claim 6. (EX1002, ¶217.)

b. [7A]

Eder meets this element for at least the reasons described above for [6A]. (EX1002, ¶218.) For example, Eder’s rear view assembly 10 “delivers real-time wide-angle video images to the driver 9” such that the images have “the same view as that of the desired mirror glass.” (EX1009, 3:10-15, 4:3-7; EX1002, ¶218.) The POSITA would recognize that such video images would exhibit consistent frame-to-frame lens characteristics, at least because they otherwise would not have the same view as the same desired mirror glass. (EX1002, ¶218.)

9. Claim 8

a. [Preamble]

Eder meets the preamble as described above for claim 7. (EX1002, ¶219.)

b. [8A]

Eder meets this element. (EX1002, ¶220.) For example, Eder discloses

adapting the field of view to the driver's position, such as by “moving section A on the optical sensor, so that other pixels of the optical sensors are visualized,” or by recalculating the image of the optical sensor. (EX1009, 5:26-34; EX1002, ¶220.)

Fig. 8 illustrates:

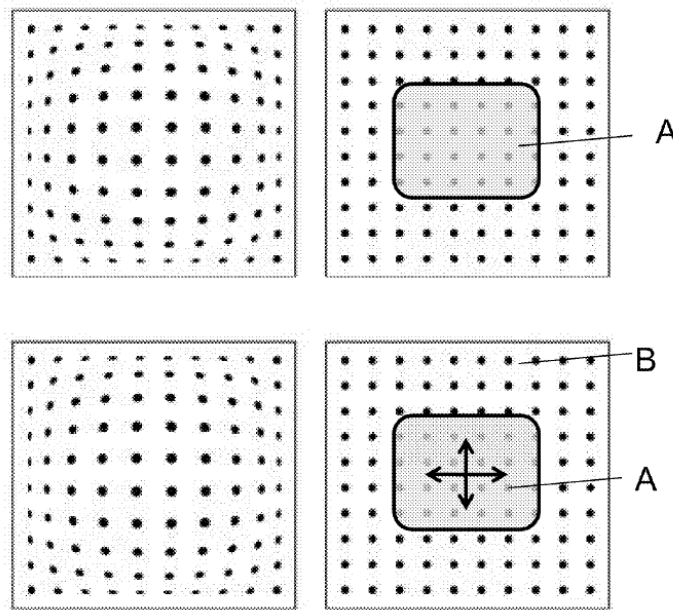


Fig. 8

(EX1009, 2:10, Fig. 8; EX1002, ¶220.)

As Eder discloses, this “mirror adjustment” is analogous to a conventional mirror, in which an electric drive adapts the mirror to the driver's perspective, thus re-pointing the field of view for the driver. (EX1009, 5:26-34; EX1002, ¶221.)

10. Claim 9**a. [Preamble]**

Eder meets the preamble as described above for claim 8. (EX1002, ¶222.)

b. [9A]

Eder meets this element. (EX1002, ¶223.) For example, the image rectification process can be performed by a computation unit (*e.g.*, a processor, DSP, FPGA, or ASIC) such as described above for [1A], according to programming of a computer-readable medium (*e.g.*, a ROM) such as described above for [1B]. (EX1009, 3:48-62; EX1002, ¶223.) Further, this image rectification can be “*formed integrally* with the imaging means”—understood, in context, to refer to inclusion of the processor and computer-readable medium components within the camera 6 that performs the imaging. (EX1009, 3:58-62; EX1002, ¶223.)

11. Claim 10**a. [Preamble]**

Eder meets the preamble as described above for claim 9. (EX1002, ¶224.)

b. [10A]

Eder meets this element as described above for [1C]. (EX1002, ¶225.) For example, Eder discloses the camera 6 includes a “wide angle lens” that imparts a perspective effect and a visual distortion (*e.g.*, barrel distortion). (EX1009, 4:14-31, 6:16; EX1002, ¶225.)

c. [10B]

Eder meets this element as described above for [1C]. (EX1002, ¶226.) For example, the POSITA would recognize that the perspective effect and visual distortion can cause straight lines in the scene to appear as curved lines near edges of the input images. (EX1009, 4:14-31; EX1002, ¶226.) For instance, Eder discloses that “lines on one side of the image” may be affected by barrel distortion or pin-cushion distortion. (EX1009, 4:42-50; EX1002, ¶226.) The POSITA would recognize that such distortion would result in the appearance of curved lines, such as shown in Fig. 8 and Fig. 2A:

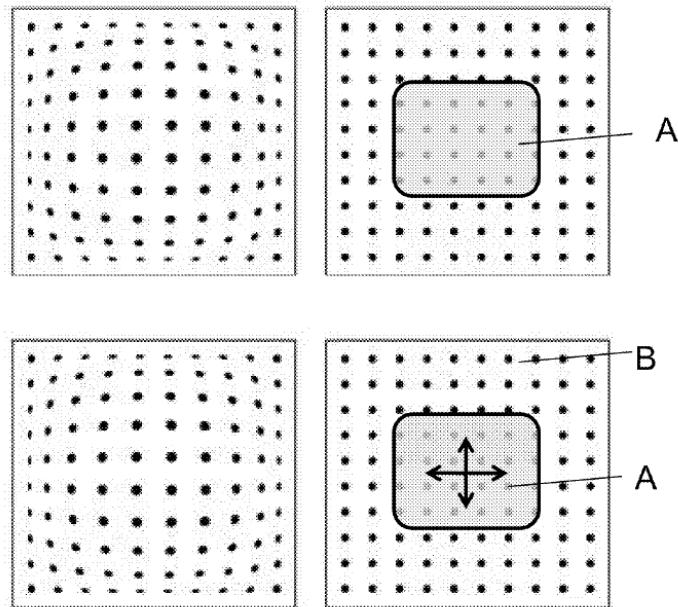
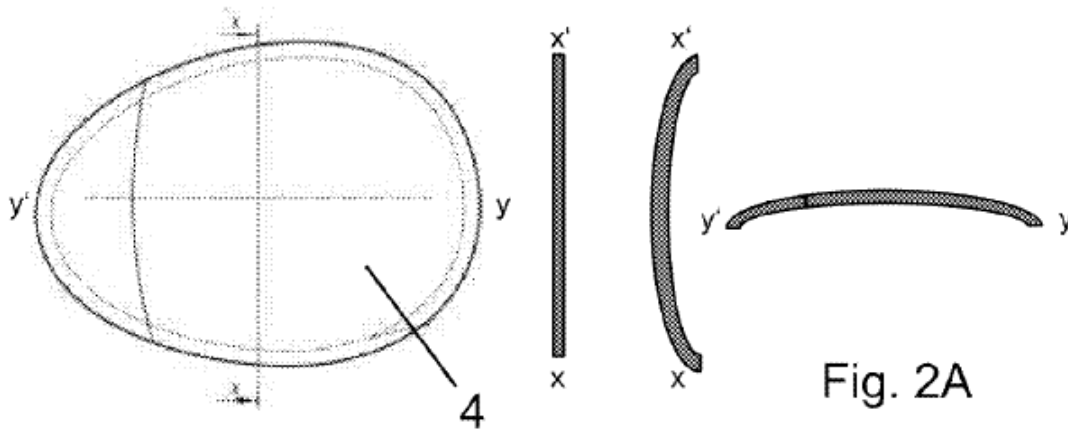


Fig. 8



(EX1009, 2:10, 2:32-37, Figs. 2A, 8; EX1002, ¶226.)

12. Claim 11

a. [Preamble]

Eder meets the preamble as described above for claim 1. (EX1002, ¶227.)

b. [11A]

Eder meets this element as described above for [1C]. (EX1002, ¶228.)

c. [11B]

Eder meets this element as described above for [1D]. (EX1002, ¶229.)

d. [11C]

Eder meets this element as described above for [1E]. (EX1002, ¶230.)

e. [11D]

Eder meets this element as described above for [1F]. (EX1002, ¶231.)

f. [11E]

Eder meets this element as described above for [1G]. (EX1002, ¶232.)

13. Claim 12**a. [Preamble]**

Eder meets the preamble as described above for claim 11. (EX1002, ¶233.)

b. [12A]

Eder meets this element as described above for [2A]. (EX1002, ¶234.)

14. Claim 13**a. [Preamble]**

Eder meets the preamble as described above for claim 11. (EX1002, ¶235.)

b. [13A]

Eder meets this element as described above for [3A]. (EX1002, ¶236.)

15. Claim 14**a. [Preamble]**

Eder meets the preamble as described above for claim 13. (EX1002, ¶237.)

b. [14A]

Eder meets this element as described above for [4A]. (EX1002, ¶238.)

16. Claim 15**a. [Preamble]**

Eder meets the preamble as described above for claim 13. (EX1002, ¶239.)

b. [15A]

Eder meets this element as described above for [5A]. (EX1002, ¶240.)

17. Claim 16**a. [Preamble]**

Eder meets the preamble as described above for claim 11. (EX1002, ¶241.)

b. [16A]

Eder meets this element as described above for [6A]. (EX1002, ¶242.)

18. Claim 17

a. [Preamble]

Eder meets the preamble as described above for claim 16. (EX1002, ¶243.)

b. [17A]

Eder meets this element as described above for [7A]. (EX1002, ¶244.)

19. Claim 18

a. [Preamble]

Eder meets the preamble as described above for claim 17. (EX1002, ¶245.)

b. [18A]

Eder meets this element as described above for [8A]. (EX1002, ¶246.)

20. Claim 19

a. [Preamble]

Eder meets the preamble as described above for claim 18. (EX1002, ¶247.)

b. [19A]

Eder meets this element as described above for [9A]. (EX1002, ¶248.)

21. Claim 20

a. [Preamble]

Eder meets the preamble as described above for claim 19. (EX1002, ¶249.)

b. [20A]

Eder meets this element as described above for [10A]. (EX1002, ¶250.)

c. [20B]

Eder meets this element as described above for [10B]. (EX1002, ¶251.)

V. THE BOARD SHOULD NOT DENY INSTITUTION UNDER *FINTIV*

The USPTO Interim Procedure for Discretionary Denials stated, “[t]he plain language of the *Fintiv* factors is directed to district court litigation and does not apply to parallel U.S. International Trade Commission (ITC) proceedings, as the ITC lacks authority to invalidate a patent and the ITC’s invalidity rulings are not binding on the Office or on the district courts.” Memorandum, USPTO Interim Procedure For Discretionary Denials In AIA Post-Grant Proceedings With Parallel District Court Litigation, 2-3. Accordingly, the Board should not exercise its discretion to deny institution.

VI. THE BOARD SHOULD NOT DENY INSTITUTION UNDER § 325(D)

The Petition does not raise the same or substantially the same art previously presented to the Office, nor does it raise the same or substantially the same arguments previously presented to the Office in the examination of the ’052 patent. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Gerate GmbH*, IPR2019-01469, Paper 6 (PTAB Feb. 13, 2020) (precedential). None of the references of any of the grounds in this Petition were presented to, or considered

by the Office. Moreover, because the claims were never rejected under any statutory prior art grounds, no argument over the prior art was previously presented to the Office during examination. The Board accordingly should not deny institution under § 325(d).

VII. NOTICES AND STATEMENTS

Pursuant to 37 C.F.R. § 42.8(b)(1), Arashi Vision Inc. (d/b/a Insta360) is the real party-in-interest for Petitioner.

Pursuant to 37 C.F.R. § 42.8(b)(2), Petitioner identifies the following related matters:

- *In the Matter of Certain Cameras, Camera Systems, and Accessories Used Therewith*, Inv. No. 337-TA-1400 (USITC)
- *GoPro, Inc. v. Arashi Vision Inc. et al.*, No. 8:24-cv-00681-HDE-JCV (C.D. Cal.).

Pursuant to 37 C.F.R. § 42.8(b)(3), Petitioner identifies the following counsel (and a power of attorney accompanies this Petition).

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Pursuant to 37 C.F.R. § 42.8(b)(4), service information for lead and back-up counsel is provided above. Petitioner consents to electronic service by email to MoFo_Insta360-IPRs@mofo.com.

Pursuant to 37 C.F.R. § 42.104(a), Petitioner certifies that the '052 patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting an *inter partes* review challenging the patent claims on the grounds identified in this Petition.

The USPTO is authorized to charge any required fees, including the fee as set forth in 37 C.F.R. § 42.15(a) and any excess claim fees, to Deposit Account No. **03-1952** referencing Docket No. **33316-00000.03.**

Dated: October 15, 2024

Respectfully submitted,

/s/ Alex S. Yap

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Certification of Word Count (37 C.F.R. § 42.24)

I hereby certify that this Petition for *Inter Partes* Review has 13,907 words (as counted by the Word Count feature of the Microsoft Word™ word-processing system), exclusive of a table of contents, a table of authorities, mandatory notices under § 42.8, a certificate of service or word count, or appendix of exhibits or claim listing.

Dated: October 15, 2024

By: */Bryan Blumenkopf/*
Bryan Blumenkopf

Certificate of Service (37 C.F.R. § 42.6(e)(4) and 42.205(a))

I hereby certify that the attached Petition for *Inter Partes* Review and supporting materials were served as of the below date by UPS, which is a means at least as fast and reliable as U.S. Express Mail, on the Patent Owner at the correspondence addresses indicated for U.S. Patent No. 10,529,052:

Esplin & Associates (GoPro)
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Dated: October 15, 2024

By: */Bryan Blumenkopf*
Bryan Blumenkopf