

Petition for *Inter Partes* Review of
U.S. Patent No. 8,451,339

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Nikon Corporation, Panasonic Entertainment & Communication Co., Ltd.,
Olympus Corporation, OM Digital Solutions Corporation, FUJIFILM North
America Corporation, FUJIFILM Corporation,

Petitioners,

v.

Optimum Imaging Technologies LLC,
Patent Owner.

Case IPR2024-01372

Patent No. 8,451,339

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 8,451,339**

TABLE OF CONTENTS

	Page
I. Introduction.....	1
II. Requirements for IPR	3
A. Standing.....	3
B. Challenge and Relief Requested	3
III. Overview Of The '339 Patent.....	4
A. Summary	4
B. Relevant Prosecution History.....	5
C. Priority Date	6
D. Level of Ordinary Skill in the Art.....	7
E. Claim Construction	7
IV. Prior Art Overview	7
A. Niikawa.....	7
B. Matsutani	13
C. Enomoto	15
D. Ito.....	16
E. Shiomi.....	16
F. Enomoto II.....	17
V. The Challenged Claims Are Unpatentable	18
A. Grounds 1(a) and 1(b)	18
1. Independent Claim 1	18
2. Claim 2	43
3. Claim 3	43
4. Claim 5	46
5. Independent Claim 14.....	49
6. Claim 15	54
7. Claim 17	55

TABLE OF CONTENTS

	Page
8. Claim 18	55
B. Grounds 2(a) and 2(b)	56
1. Claim 4	56
2. Claim 16	58
C. Ground 3	59
1. Independent Claim 1	59
2. Claim 2	72
3. Independent Claim 14	73
4. Claim 15	77
5. Claim 17	78
D. Ground 4	78
1. Claim 3	78
2. Claim 5	81
3. Claim 18	83
E. Ground 5	83
1. Claim 4	83
2. Claim 16	84
F. Secondary Considerations of Non-Obviousness	84
VI. Discretionary Denial is Unwarranted	85
A. <i>General Plastic</i> Favors Institution	85
B. <i>Sotera</i> Stipulations Moot <i>Fintiv</i>	87
C. 35 U.S.C. § 325(d)	87
VII. Payment of Fees	87
VIII. Mandatory Notices	88
A. Real Party-in-Interest	88
B. Related Matters	88

TABLE OF CONTENTS

	Page
1. U.S. District Court for the Eastern District of Texas.....	88
2. U.S. District Court for the Western District of Texas	88
3. U.S. District Court for the Northern District of California.....	89
C. Notice of Counsel and Service Information.....	89
IX. Conclusion	90

TABLE OF EXHIBITS

Exhibit	Description
Ex-1001	U.S. Pat. No. 8,451,339 (“’339 Patent”)
Ex-1002	Prosecution History of the ’339 Patent Sans NPL
Ex-1003	Declaration of Expert Witness, Dr. Robert L. Stevenson
Ex-1004	Curriculum Vitae of Expert Witness, Dr. Robert L. Stevenson
Ex-1005	U.S. Pat. App. Pub. No. 2002/0135688 (“Niikawa”)
Ex-1006	Certified Translation of Japanese Pat. App. Pub. No. 2004-266768 (“Matsutani”)
Ex-1007	Japanese Pat. App. Pub. No. 2004-266768 (“Matsutani-JP”)
Ex-1008	U.S. Pat. No. 6,323,934 (“Enomoto”)
Ex-1009	Certified Translation of Japanese Pat. App. Pub. No. H6-113309 (“Ito”)
Ex-1010	Japanese Pat. App. Pub. No. H6-113309 (“Ito-JP”)
Ex-1011	Certified Translation of Japanese Pat. App. Pub. No. H5-3568 (“Shiomi”)
Ex-1012	Japanese Pat. App. Pub. No. H5-3568 (“Shiomi-JP”)
Ex-1013	U.S. Pat. No. 7,245,319 (“Enomoto II”)
Ex-1014	U.S. Patent No. 9,063,982 (“Bestgen”)
Ex-1015	U.S. Patent No. 6,920,443 (“Cesare”)
Ex-1016	U.S. Pat. No. 7,612,805 (“’805 Patent”)
Ex-1017	U.S. Pat. No. 5,276,519 (“Richards”)
Ex-1018	U.S. Pat. No. 6,862,373 (“Enomoto III”)
Ex-1019	Prosecution History of the ’805 Patent
Ex-1020	U.S. Pat. No. 5,477,264 (“Sarbadhikari”)
Ex-1021	Certified Translation of Japanese Pat. App. Pub. No. H11-205652 (“Ichiyama”)
Ex-1022	Japanese Pat. App. Pub. No. H11-205652 (“Ichiyama-JP”)
Ex-1023	U.S. Patent No. 7,683,950 (“Kelly”)
Ex-1024	<i>Sotera</i> Stipulation for Petitioners
Ex-1025	Certified Translation of <i>Ricoh Technical Report No. 31</i> , RICOH (Apr. 20, 2006), https://web.archive.org/web/20060420051054/http://www.ricoh.co.jp/about/business_overview/report/31/ (“Ricoh”)
Ex-1026	<i>Ricoh Technical Report No. 31</i> , RICOH (Apr. 20, 2006), https://web.archive.org/web/20060420051054/http://www.ricoh.co.jp/about/business_overview/report/31/ (“Ricoh-JP”)

LIST OF CHALLENGED CLAIMS

Limitation	Claim Language
[1pre]	A digital imaging system for correcting optical image aberrations comprising:
[1A-1]	a digital camera mechanism,
[1A-2]	an optical lens mechanism,
[1A-3]	a digital sensor,
[1A-4]	a microprocessor,
[1A-5]	a digital signal processor,
[1A-6]	system software,
[1A-7]	a database management system and
[1A-8]	a memory storage sub-system;
[1B]	wherein the optical lens mechanism is a fixed focal length lens;
[1C]	wherein a microprocessor uses system software to identify at least one optical aberration by accessing the database;
[1D]	wherein the microprocessor uses the database to identify at least one algorithm to use to correct the at least one optical aberration;
[1E]	wherein when the image file is captured by the digital sensor the digital file is forwarded to the digital signal processor;
[1F]	wherein the image file with the at least one optical aberration is corrected by applying digital filtration by using at least one algorithm in the digital signal processor; and
[1G]	wherein the modified digital file consisting of the digital data optimized from the at least one optical aberration that are corrected from the original optical image is stored in memory.
[2]	The system of claim 1: wherein the optical aberrations include at least one of spherical, comatic, lens distortion, astigmatism, curvature of field, pin cushion, barrel distortion, chromatic aberrations, scattered light, red eye, dust and/or flare types of optical aberrations.
[3pre]	The system of claim 1:
[3A]	wherein the optical aberration is vignetting;
[3B]	wherein the digital signal processor applies neutral density filtration from one third of a stop to three stops in the center of the image and/or wherein the digital signal processor applies an algorithm to lighten the corners of the image or the digital signal processor applies both neutral density filtration in the image

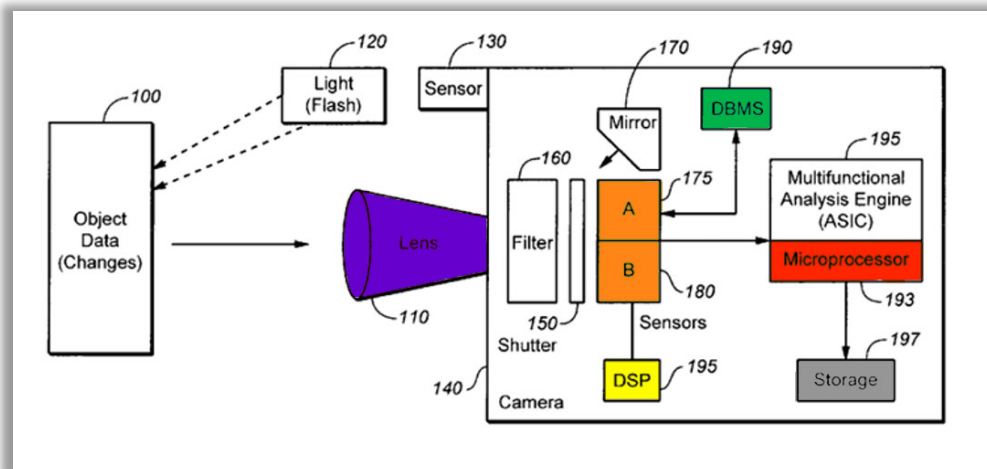
	center and/or an algorithm to lighten the corners of the image; and
[3C]	wherein the image exposure is optimized to correct the vignetting.
[4]	The system of claim 1: wherein the digital signal processor applies at least one fast Fourier transform (FFT) algorithm to correct the at least one optical aberration.
[5pre]	The system of claim 1:
[5A]	wherein each lens type is registered in the camera database;
[5B]	wherein the multiple optical aberrations of each lens is listed in the database;
[5C]	wherein the filtration solutions to the lens optical aberrations are listed in the database;
[5D]	wherein the filtration of each lens optical aberration is applied by the digital signal processor; and
[5E]	wherein after the digital signal processor applies the filtration to correct the optical aberrations the corrected digital file is forwarded to storage in memory.
[14pre]	A digital imaging system for correcting image aberrations comprising:
[14A-1]	a digital camera mechanism,
[14A-2]	an optical lens mechanism,
[14A-3]	a digital sensor,
[14A-4]	a microprocessor,
[14A-5]	a digital signal processor,
[14A-6]	system software,
[14A-7]	a database management system and
[14A-8]	a memory storage sub-system;
[14B]	wherein the optical lens mechanism is a zoom lens;
[14C]	wherein the zoom lens changes focal length positions;
[14D]	wherein when the image file is captured by the digital sensor the file is forwarded to the digital signal processor and to memory;
[14E]	wherein the microprocessor uses system software to access the database to identify at least one optical aberration in the image file at any focal length of a zoom lens configuration;
[14F]	wherein the microprocessor accesses the database to obtain at least one filtration correction algorithm to the optical aberrations

	and forwards the at least one filtration algorithms to the digital signal processor;
[14G]	wherein the image file is forwarded to the digital signal processor which applies at least one filtration algorithm to optimize the image and corrects the at least one optical aberration at the specific focal length in the zoom lens configuration; and
[14H]	wherein the modified image file consisting of the digital data optimized from the at least one optical aberration of a specific focal length of the zoom lens that are corrected from the original optical image is stored in memory.
[15]	The system of claim 14: wherein the optical aberrations include vignetting, spherical, comatic, lens distortion, chromatic aberrations, curvature of field, pin cushion, barrel distortion, scattered light, red eye, dust and/or flare types of optical aberrations.
[16]	The system of claim 14: wherein the digital signal processor applies a fast Fourier transform (FFT) algorithm to correct optical and/or digital aberrations.
[17]	The system of claim 14: wherein each focal length of a zoom lens is analyzed for a different set of optical aberrations.
[18pre]	The system of claim 14:
[18A]	wherein the optical aberration is vignetting;
[18B]	wherein the digital signal processor applies neutral density filtration from one third of a stop to three stops in the center of the image and/or wherein the digital signal processor applies an algorithm to lighten the corners of the image or the digital signal processor applies both neutral density filtration in the image center and/or an algorithm to lighten the corners of the image; and
[18C]	wherein the image exposure is optimized to correct the vignetting.

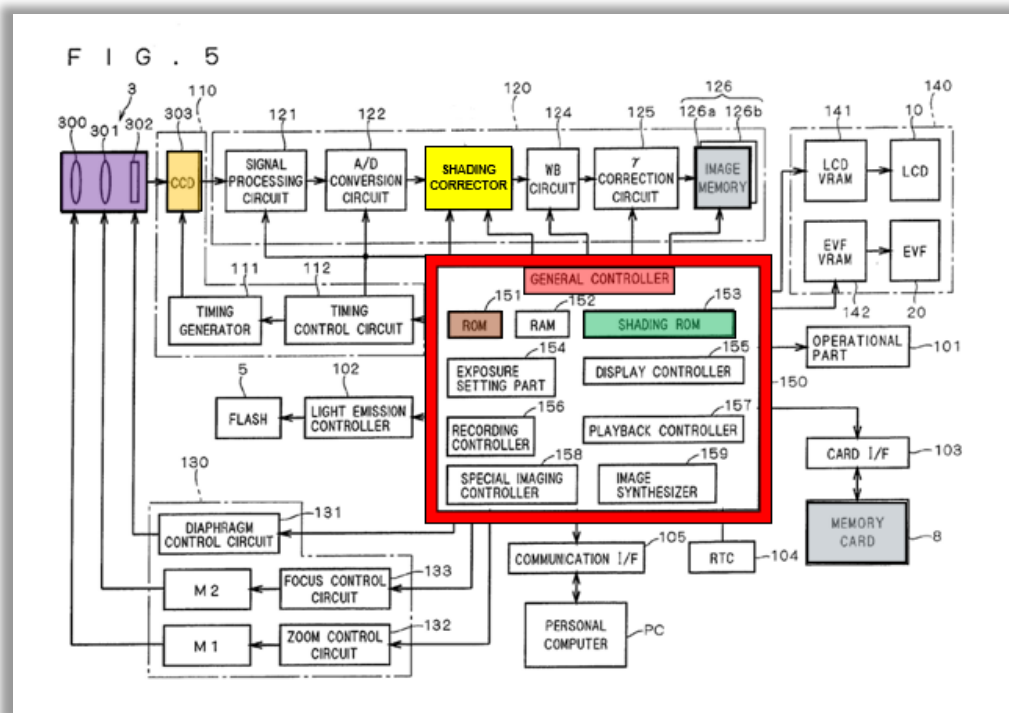
I. Introduction

Digital cameras capture images by an image sensor receiving light that passes through a lens, processing the data from the image sensor, and storing the image in memory. The image quality of the stored image may be adversely affected by distortions and artifacts caused by lenses. These adverse effects are known as “aberrations.” Such aberrations include “vignetting,” where less light is received at the edge of the image, causing the edges to be shaded.

Techniques for correcting aberrations were well known. Acknowledging that correcting aberrations post-production (e.g., using Photoshop on a computer) was well known (Ex-1001, 6:31-36), the '339 Patent describes and claims using well-known aberration correcting techniques in the camera itself utilizing the components of a camera, including (i) a lens (purple), (ii) a digital sensor (orange), (iii) a digital signal processor (yellow), (iv) a microprocessor (red), (v) software, (vi) a database management system (green), and (vii) a memory (grey).



But correcting aberrations in-camera had been known for years. For example, Niikawa discloses a digital camera that corrects vignetting using the components of the camera. Like the '339 Patent, Niikawa discloses correcting aberrations in a camera using a (i) lens (purple), (ii) CCD image sensor (orange), (iii) shading corrector processor (yellow), (iv) general controller (red), (v) programs stored in the general controller's memory (brown), (vi) correction tables stored in the general controller's shading ROM (green), and (vii) memory (grey).



As detailed herein, correcting aberrations in camera was not novel as taught by Niikawa, Matsutani, and many other references. And implementing well-known aberration techniques in camera was certainly obvious. Thus, trial should be instituted and claims 1-5 and 14-18 ("Challenged Claims") should be cancelled.

II. Requirements for IPR

A. Standing

Petitioners certify that the '339 Patent is available for IPR, and that Petitioners are not barred or estopped from requesting this review.

B. Challenge and Relief Requested

Petitioners rely on the following references that qualify as prior art under 35 U.S.C. §102(b):

- Niikawa (Ex-1005) published on September 26, 2002.
- Matsutani (Ex-1006) published on September 24, 2004.
- Enomoto (Ex-1008) issued on November 27, 2001.
- Ito (Ex-1009) published on April 22, 1994.
- Shiomi (Ex-1011) published on January 8, 1993.

Petitioners rely on Enomoto II (Ex-1013), which was filed on June 11, 1999 and issued on July 17, 2007, and thus qualifies as prior art under 35 U.S.C. § 102(e).

Petitioners request that the Challenged Claims be determined unpatentable and cancelled on the following grounds:

Ground 1(a): Claims 1, 3, and 5 are obvious over Niikawa.

Ground 1(b): Claims 1-3, 5, 14-15, and 17-18 are obvious over Niikawa in view of Enomoto.

Ground 2(a): Claim 4 is obvious over Niikawa in view of Ito.

Ground 2(b): Claims 4 and 16 are obvious over Niikawa in view of Enomoto and Ito.

Ground 3: Claims 1-2, 14-15 and 17 are obvious over Matsutani in view of Shiomi.

Ground 4: Claims 3, 5 and 18 are obvious over Matsutani in view of Shiomi and Enomoto II.

Ground 5: Claims 4 and 16 are obvious over Matsutani in view of Shiomi and Ito.

This Petition is supported by the Declaration of Dr. Robert L. Stevenson (Ex-1003).

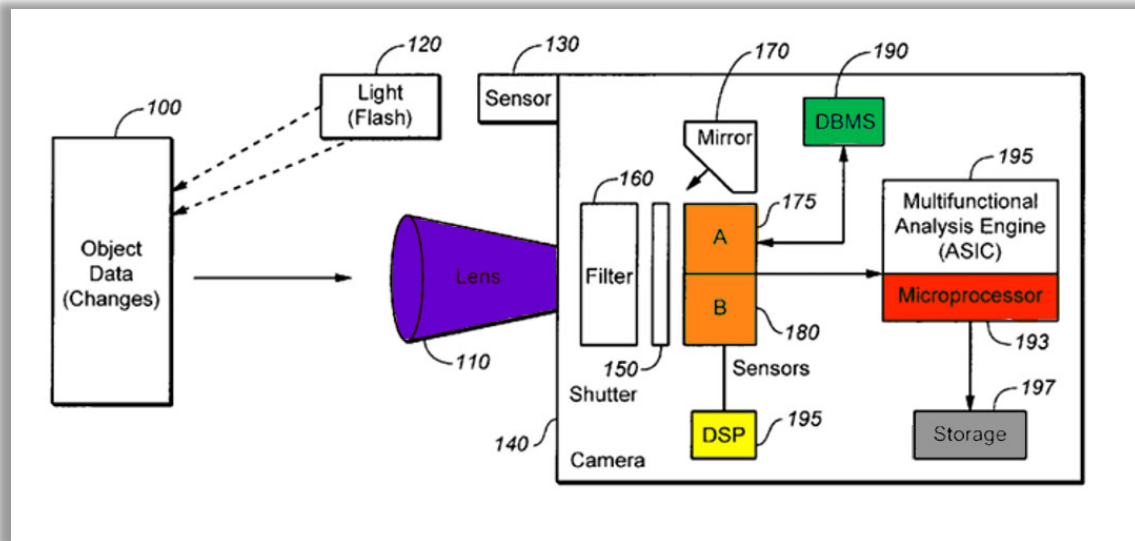
III. Overview Of The '339 Patent

A. Summary

The '339 Patent discloses in-camera digital corrections to aberrations. Ex-1001, 8:3-4. The '339 Patent admits that existing optical technologies reliably corrected for imaging aberrations, asserting that those technologies lacked “in-camera modification capabilit[ies] for each specific image problem.” *Id.*, 6:54-58; *see also* 1:37-45, 2:38-56, 3:25-26, 3:40-53, 4:25-38, 5:6-35, 6:18-30.

The patent describes a digital camera capable of identifying and correcting for optical image aberrations. *Id.*, claim 1. The camera includes (i) an optical lens mechanism (e.g., lens 110, purple), (ii) a digital sensor (e.g., digital sensor 175 or

180, orange), (iii) a digital signal processor (e.g., DSP 195, yellow), (iv) a microprocessor (e.g., microprocessor 193, red), (v) a database management system (e.g., DBMS 190, green), and (vi) a memory storage sub-system (e.g., storage 197, grey). *See id.*, claim 1; Ex-1003, ¶¶71-72.



Ex-1001, Fig. 1.

B. Relevant Prosecution History

During prosecution, the Examiner took official notice that many claimed elements were “old and well known in the art,” including: “a system wherein the digital signal processor applies at least one FFT algorithm to correct the at least one optical aberration,” “the digital signal processor applies color filtration to the image file,” “the optical lens mechanism is a zoom lens,” “the zoom lens changes focal length positions on a continuous scale,” and “each focal length of a zoom lens is analyzed for a different set of optical aberrations.” Ex-1002, 136-139, 143.

In response, the applicant acknowledged that a “microprocessor is a CPU that controls the computing functions [in a digital] camera,” that “[t]he CPU may use memory circuits (DRAM, EPROM, EEPROM, Flash memory) in order to store and access data to perform a set of control functions,” that “a digital signal processor (DSP) ... is used to process a digital image file,” and that “[a] DSP may be used to process these digital filter components in order to eliminate digital or color artifacts related to specific image sensor pixels.” *Id.*, 120-121. The applicant also acknowledged that “the applicant does not claim to invent” “the FFT algorithm,” and in reference to the FFT algorithm, that “[t]here is no reason not to include a powerful class of algorithm to the toolbox in order to solve the aberrations.” *Id.*, 123.

A notice of allowance issued after the applicant’s response. *Id.*, 82. The ’339 Patent issued on May 28, 2013.

Niikawa, Enomoto, Ito, Matsutani, Shiomi, and Enomoto II were not cited during prosecution of the ’339 Patent.

C. Priority Date

For purposes of this proceeding only, Petitioners assume that the provisional application’s filing date, July 11, 2006, is the priority date (“Priority Date”). This is before March 16, 2013, so the pre-AIA statute applies.

D. Level of Ordinary Skill in the Art

A person having ordinary skill in the art (“POSA”) would have had a bachelor’s degree in electrical engineering, physics, or a related field, with at least two years of industry experience and/or research, both concerning digital camera system design and image processing. Ex-1003, ¶¶50-52.

E. Claim Construction

Petitioners believe that the plain and ordinary meanings suffice and no further constructions are needed to resolve the issues presented in this Petition. Ex-1003, ¶53.

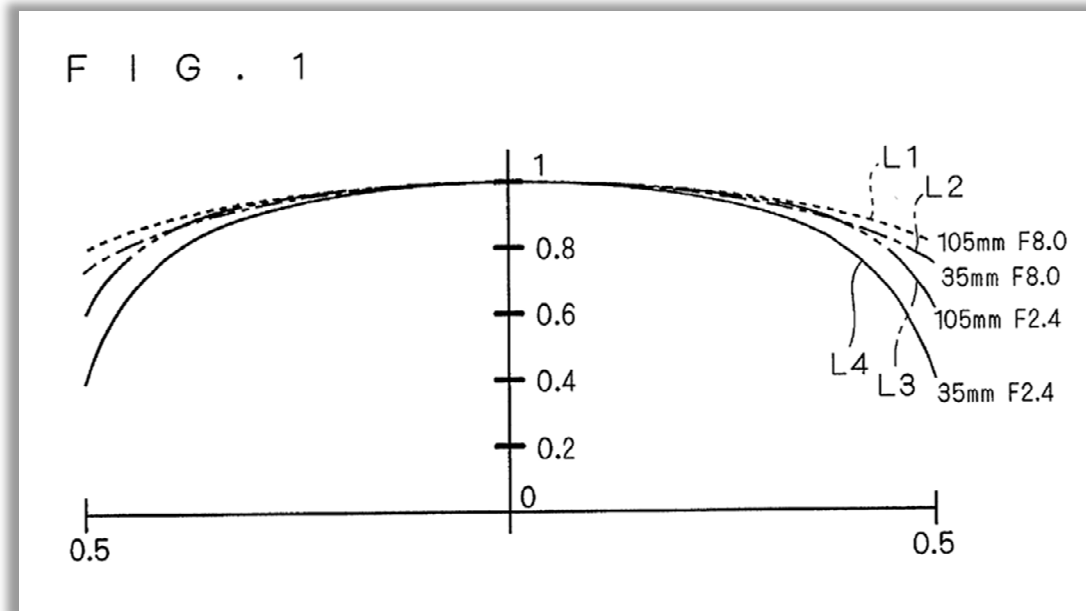
IV. Prior Art Overview

A. Niikawa

Niikawa discloses an image processing apparatus, e.g., a digital camera, having a lens 3 and CCD sensor 303, that performs shading correction on images, which is a form of image aberration correction. *See, e.g.*, Ex-1005, Abstract, [0067]. “When an image is captured via a lens in a digital camera or the like, so-called ‘shading’ [occurs meaning] that the level of image data decreases with distance from the center of the image to the periphery.” *Id.*, [0012], *see also id.*, [0056].

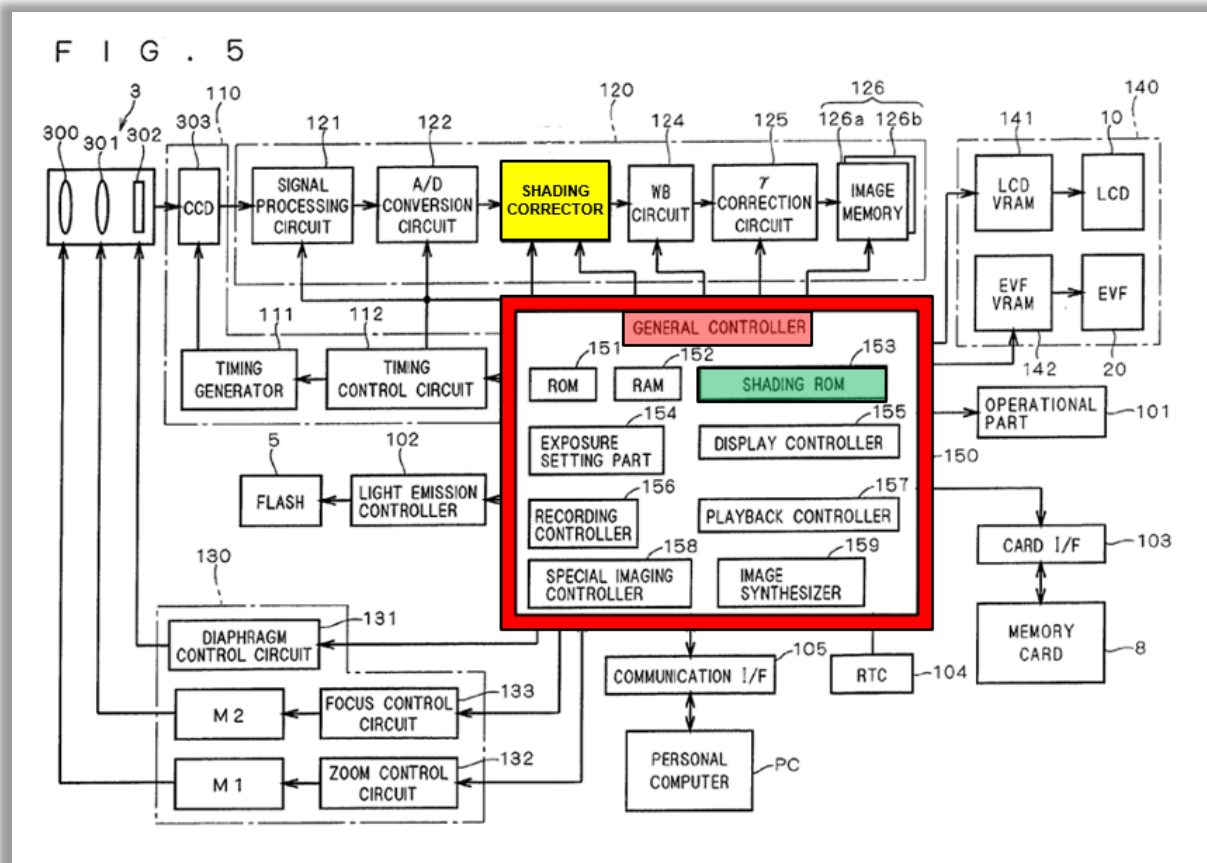
Figure 1 depicts an example of how shading can influence an image captured using a digital camera with lenses at different focal lengths and “f-numbers.” *Id.*,

[0057]-[0060]. As shown in Figure 1, focal length (represented in mm) and f-number influence shading. *Id.*, [0060].



Ex-1005, Fig. 1.

Niikawa teaches a signal processor 120 with a shading corrector that corrects shading due to optical conditions. Ex-1005, [0082], Claims 1, 2, 4, 5. The shading corrector works with general controller 150 (red) and shading ROM 153 (green) to correct the shading aberration in each image. Niikawa discloses that the shading corrector may be implemented as a hardware circuit, as in shading correction circuit 123 (of original Figure 5), or the shading corrector may be implemented using a processor (shown in yellow in amended Figure 5 below). *Id.*, [0030], [0078]-[0079], [0082], [0108], [0110], [0122], Figs. 5-6, Claims 1, 2, 4, 5.



Ex-1005, Fig. 5 (with shading corrector processor).

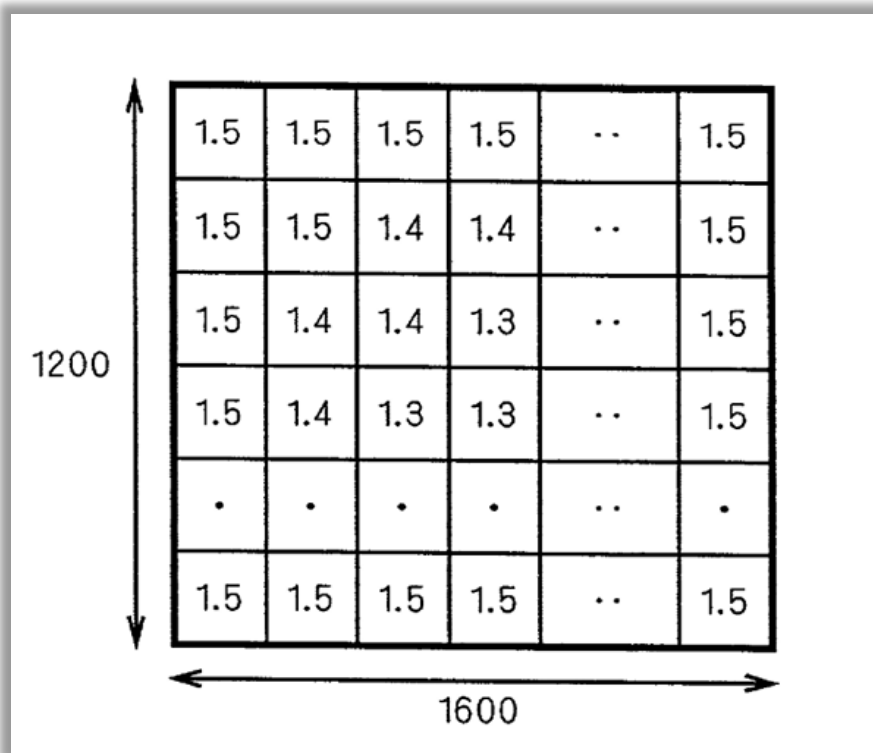
Specifically, claim 1 of Niikawa recites a “shading corrector.” Ex-1005, Claim 1. Claim 2 of Niikawa, which is dependent on claim 1, recites that the “shading corrector” can be implemented as a “coefficient processing hardware circuit.” *Id.*, Claim 2. Alternatively, claim 5 of Niikawa, which is dependent on claim 4, which depends from claim 1, recites that the “shading corrector” can be implemented as a “processor.” *Id.*, Claim 4, 5. Thus Niikawa discloses that the shading corrector can be implemented as either a hardware circuit or a processor. Ex-1003, ¶81.

Although the implementation depicted in Figure 5 of Niikawa discloses the hardware circuit implementation, a POSA reading Niikawa would have understood that the embodiment of Figure 5 could equally be implemented using the disclosed processor implementation. Ex-1003, ¶82. At a minimum, it would have been obvious to a POSA to use a processor to perform the shading correction functionality. *Id.* Such motivation is provided by Niikawa's claims themselves. *Id.* Additional motivations are explained further below.

The general controller 150 includes programs for controlling camera functions and the components of the digital camera 1. Ex-1005, [0096]. Based on the optical conditions of the lens, such as focal length and f-number, the general controller 150 selects a "correction table" with inverse correction coefficients from shading ROM 153 to send to the shading corrector. *Id.*, [0082], [0084], [0108].

Figure 7 shows an example correction table used for shading correction. *Id.*, [0031], [0083]. "As shown in [Figure 7], the correction table has 1,920,000 correction coefficients (actually, inverses of correction coefficients) for corresponding to the respective 1,920,000 pixels of 1,600 pixels×1,200 pixels of the [image pickup device] CCD 303." *Id.*, [0056], [0083]. "Each correction coefficient corresponds to the rate of decrease in level of each pixel data shown in FIG. 1, and the inverse of the correction coefficient is held in the correction table in advance." *Id.* "When each pixel shown in the curve of FIG. 1 is multiplied by the inverse of

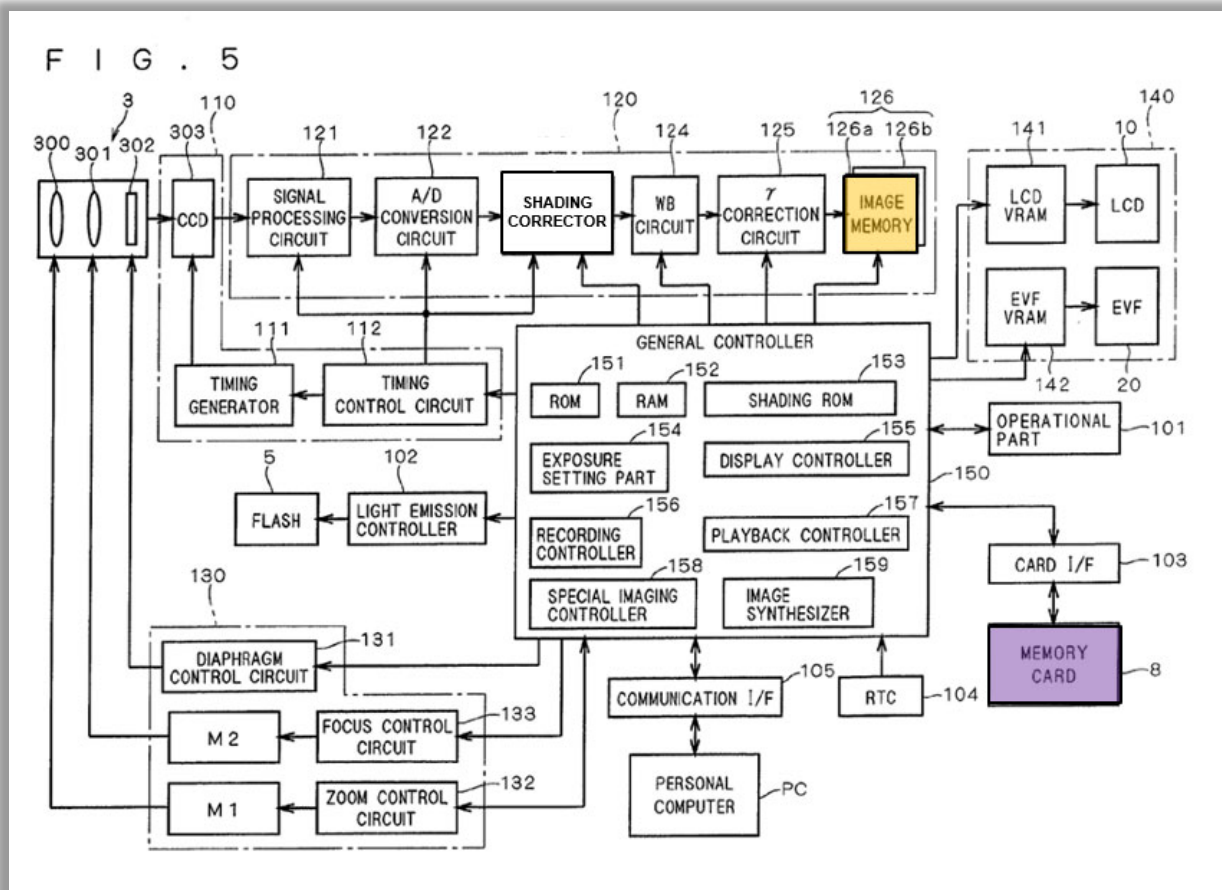
the correction coefficient, the curve is converted to a straight line in which the levels of image data are constantly 1. That is, by subjecting every pixel data to the multiplication by the inverse of the correction coefficient (coefficient process), the shading can be corrected.” *Id.*



Ex-1005, Fig. 7.

After signal processor 120 finishes processing the image, the signal processor forwards the image data to image memory 126 (orange) for temporary storage. Ex-1005, [0087], [0092]. The image data is stored in image memory 126 (orange) and/or memory card 8 (purple). *Id.*, [0093], [0100]; *see also id.*, Fig. 8 (depicting a recording method of image files onto the memory card 8), Fig. 15 (depicting a configuration

example of an image file stored in memory card 8), [0032], [0040], [0095] (disclosing that general controller 150 is connected to memory card 8 via card interface 103), [0101] (describing Fig. 8), [0149] (describing Fig. 15).



Ex-1005, Fig. 5 (with shading corrector processor).

Niikawa is analogous art at least because it is in the same field of endeavor as the '339 Patent, i.e., digital signal processing techniques, such as aberration correction, for imaging systems like digital and video cameras. *Compare* Ex-1001, 1:16-33 *with* Ex-1005, Abstract, [0003], [0065]. Niikawa also is reasonably pertinent

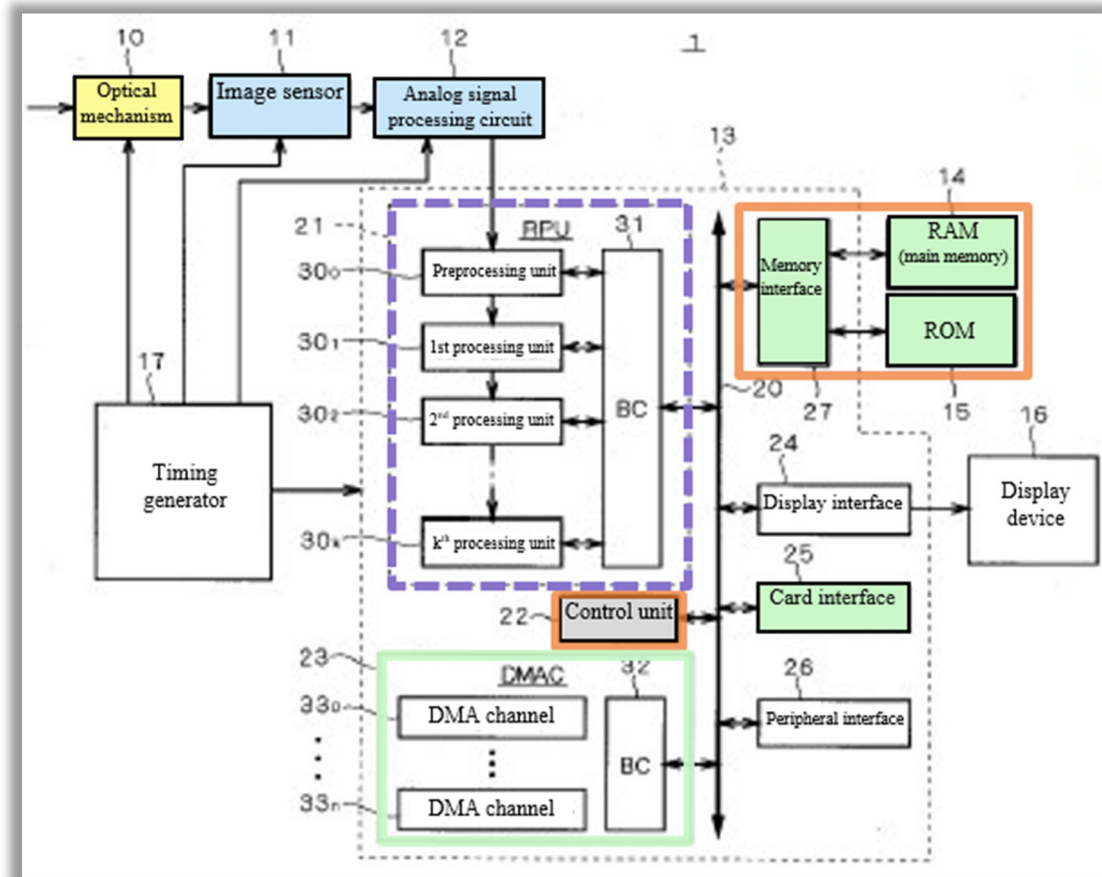
to the problem to be solved: correcting image aberrations in-camera. *Id.* Niikawa and the '339 Patent both list the H04N subclass under the International Classification. Ex-1003, ¶¶78-86.

B. Matsutani

Matsutani describes a digital camera that “reads out the correction data from a memory...and transfers it to the image processing unit” that “performs a convolution operation” and “enables correction of various aberrations in the image data that are caused by the optical mechanism.” Ex-1006, Abstract, [0008], [0029]-[0030]. The camera includes a CPU and real-time processing circuit (RPU). *Id.*, [0026]-[0030], Figs. 1, 2.

Figure 1 discloses a digital camera 1 with optical mechanism (lens) 10 (yellow), an image sensor 11 (blue), working with analog signal processing circuit 12 that includes an A/D converter (blue), for producing a digital image signal, a control unit 22 having a CPU (gray), a real-time processing circuit (RPU) 21 (purple) for performing image processing to correct aberrations, a software program stored in a ROM 15, a direct memory access controller (DMAC) 23 that operates with the control unit 22, a memory interface 27, a RAM 14 and the ROM 15 to access a database of aberration correction coefficients and transfer certain coefficients to the RPU 21, a system (orange) for accessing said database, and a RAM 14 (green) and

card memory (not shown but connectable through card interface 25) (green). *Id.*,
[0023]-[0032].



Ex-1006, Fig. 1.

Matsutani is analogous art at least because it is in the same field of endeavor as the '339 Patent, i.e., digital signal processing techniques, such as aberration correction, for imaging systems like digital and video cameras. *Compare* Ex-1001, 1:16-33 *with* Ex-1006, Abstract, [0008], [0029]-[0030]. Matsutani also is reasonably pertinent to the problem to be solved: correcting image aberrations in-

camera. *Id.* Matsutani and the '339 Patent both list H04N under the International Classification. Ex-1003, ¶¶87-89.

C. Enomoto

Enomoto discloses an image processing apparatus with a storage section for storing lens characteristics associated with the type of lens and a correcting section which receives the corresponding lens characteristics from the storage section and corrects at least one aberration selected from among lateral chromatic aberration, distortion, decrease in brightness of the edge of image field, and image blurring. Ex-1008, Abstract, 1:5-19. Enomoto also discloses that the image processing apparatus 14, “which obtains input image data from an image recorded optically with a taking lens,” can comprise the image reading apparatus 12, e.g., a digital camera. *Id.*, 11:35-52, Figs. 1, 2, 5, 8, 10, 12, Claims 11, 31, 34. The storage section can include a database, and the lens information stored in the database may be either correction functions/equations and/or coefficients for correcting lateral chromatic aberration and distortion. *Id.*, 14:4-49.

Enomoto is analogous art at least because it is in the same field of endeavor as the '339 Patent, i.e., digital signal processing techniques, such as aberration correction, for imaging systems like digital and video cameras. *Compare* Ex-1001, 1:16-33 *with* Ex-1008, Abstract, 1:5-19. Enomoto also is reasonably pertinent to the problem to be solved: correcting image aberrations in-camera. Specifically,

Enomoto corrects various aberrations for specific lens characteristics used with digital cameras. Ex-1008, Abstract, 1:5-19, 11:35-52. Enomoto and the '339 Patent both list H04N under the International Classification. Ex-1003, ¶¶90-91.

D. Ito

Claims 4 and 16 of the '339 Patent disclose “wherein the digital signal processor applies at least one fast Fourier transform (FFT) algorithm to correct the at least one optical aberration.” Ito discloses using a fast Fourier transform (“FFT”) as the chromatic aberration correction that is applied by digital signal processing. Ex-1009, ¶17.

Ito is analogous art at least because it is in the same field of endeavor as the '339 Patent, i.e., digital signal processing techniques, such as aberration correction, for imaging systems like digital and video cameras. *Compare* Ex-1001, 1:16-33 with Ex-1009, [0006]. Ito also is reasonably pertinent to the problem to be solved: correcting image aberrations in-camera. *Id.* Ito and the '339 Patent both list H04N under the International Classification. Ex-1003, ¶¶92-93.

E. Shiomi

Shiomi describes a video camera device that corrects chromatic aberration resulting from the use of a zoom lens. Ex-1011, Abstract. Shiomi discloses tables that store tables of “aberration correction coefficients” indexed to “focal length

information f_M and a focusing lens movement amount ΔN ” of the zoom lens. *Id.*, [0021], Figs. 6(b)-(c).

Shiomi is analogous art at least because it is in the same field of endeavor as the '339 Patent, i.e., digital signal processing techniques, such as aberration correction, for imaging systems like digital and video cameras. *Compare* Ex-1001, 1:16-33 *with* Ex-1011, Abstract. Shiomi also is reasonably pertinent to the problem to be solved: correcting image aberrations in-camera. *Id.* Shiomi and the '339 Patent both list H04N under the International Classification. Ex-1003, ¶¶94-95.

F. Enomoto II

Enomoto II discloses a digital image shooting device with a lens characteristic correction unit that corrects image aberrations by using pre-stored lens characteristics of the image forming lens. Ex-1013, Abstract, 6:22-37, 6:45-52. A characteristic correction unit memorizes the lens characteristics and corrects chromatic aberration, distortion aberration, etc. based on lens characteristics. *Id.*, 4:16-20. The stored lens characteristics include a function that represents the corresponding aberration. *Id.*, 4:21-33.

Enomoto II is analogous art at least because it is in the same field of endeavor as the '339 Patent, i.e., digital signal processing techniques, such as aberration correction, for imaging systems like digital and video cameras. *Compare* Ex-1001, 1:16-33 *with* Ex-1013, Abstract, 6:22-37, 6:45-52. Enomoto II also is reasonably

pertinent to the problem to be solved: correcting image aberrations in-camera. *Id.* Enomoto II and the '339 Patent both list H04N under the International Classification. Ex-1003, ¶¶96-97.

V. The Challenged Claims Are Unpatentable

A. Grounds 1(a) and 1(b)

1. Independent Claim 1

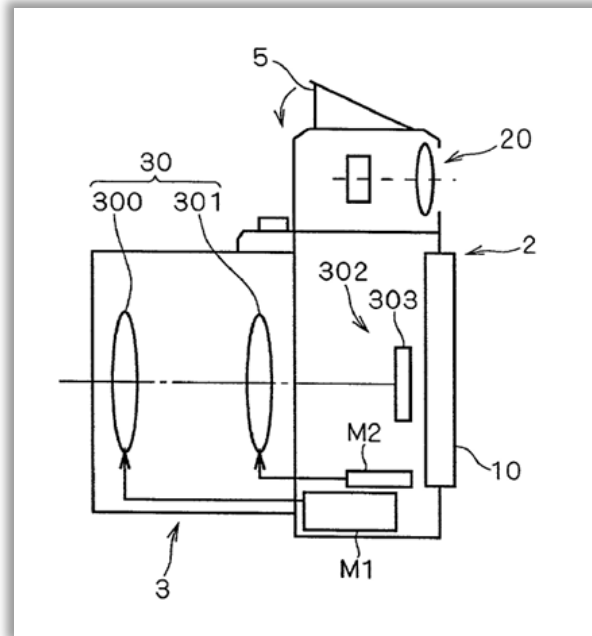
[1pre] A digital imaging system for correcting optical image aberrations comprising:

Niikawa discloses a digital imaging system, e.g., an image processing apparatus or camera, that performs shading correction on images, which is a form of optical image aberration correction. Ex-1005, Abstract, [0012], [0056], [0065], [0082], Fig. 5; Ex-1003, ¶99.

Niikawa discloses a digital imaging system (digital camera 1) for correcting optical image aberrations (shading aberrations). *Id.*, ¶100.

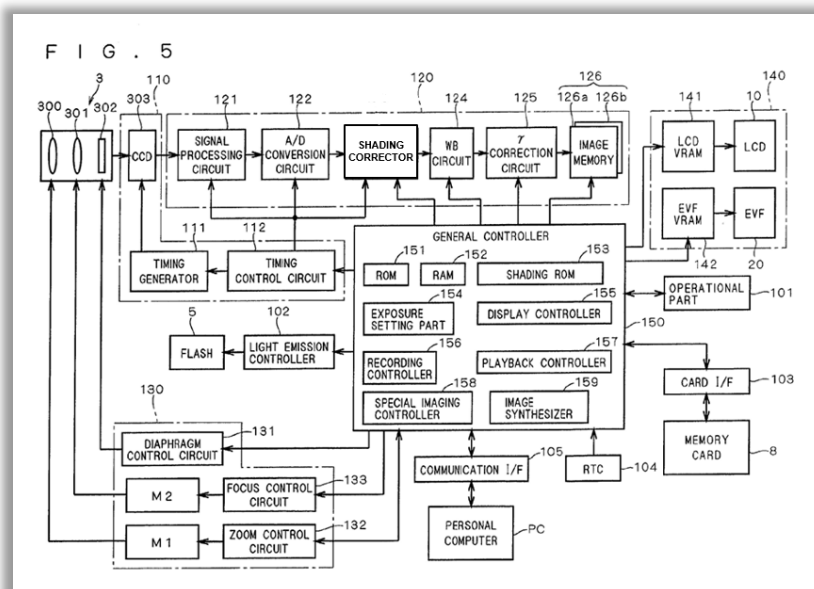
[1A-1] a digital camera mechanism,

Niikawa discloses digital camera 1. Ex-1005, Abstract, [0065], [0075], Figs. 2-5. Figure 3 depicts a cross-section view of digital camera 1 with imaging lens 3, including zoom lens 300 and focus lens 301, and camera main body 2. *Id.*, [0027], [0065], [0067], [0069], [0088]; Ex-1003, ¶103.



Ex-1005, Fig. 3.

Figure 5 depicts the internal configuration of digital camera 1. Ex-1005, [0029], [0075], Fig. 5; Ex-1003, ¶104.

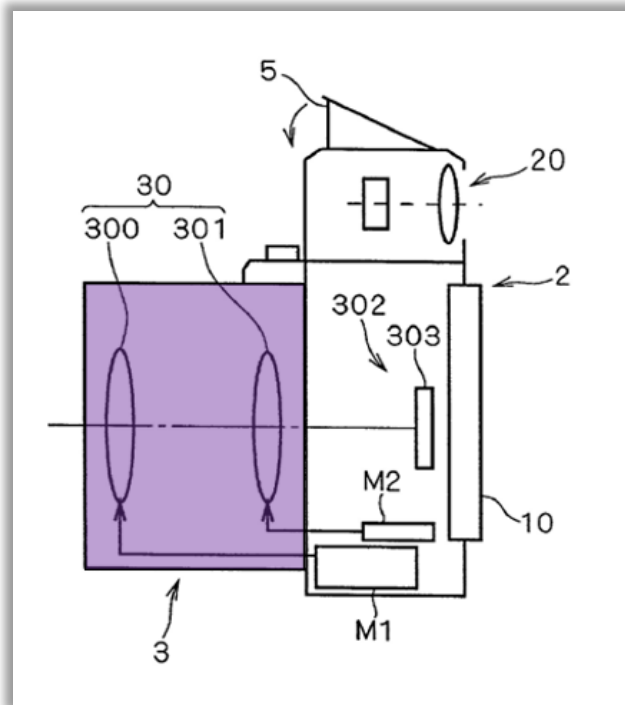


Ex-1005, Fig. 5 (with shading corrector processor).

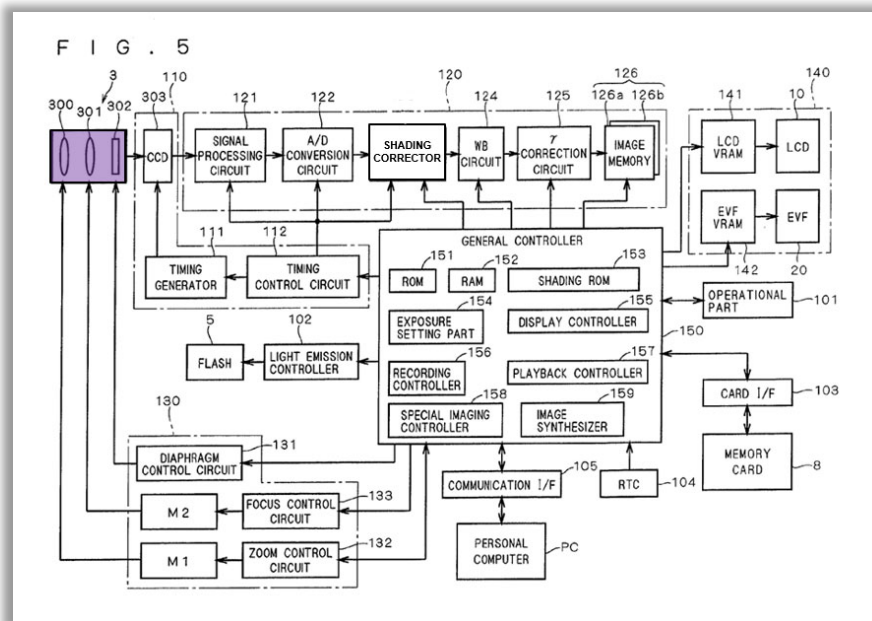
Niikawa discloses a digital camera mechanism (digital camera 1). Ex-1003, ¶105.

[1A-2] an optical lens mechanism,

Niikawa discloses that digital camera 1 has an imaging lens 3 (purple), including zoom lens 300 and focus lens 301. Ex-1005, [0066], [0067], [0076], [0089], Figs. 3, 5; Ex-1003, ¶106.



Ex-1005, Fig. 3.

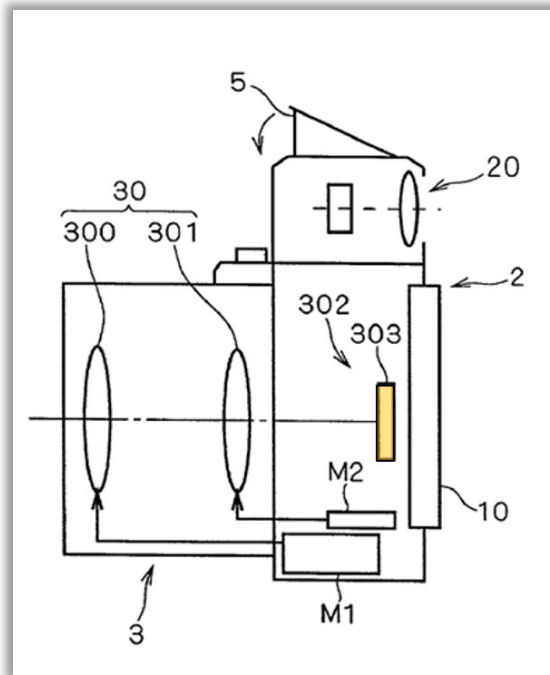


Ex-1005, Fig. 5 (with shading corrector processor).

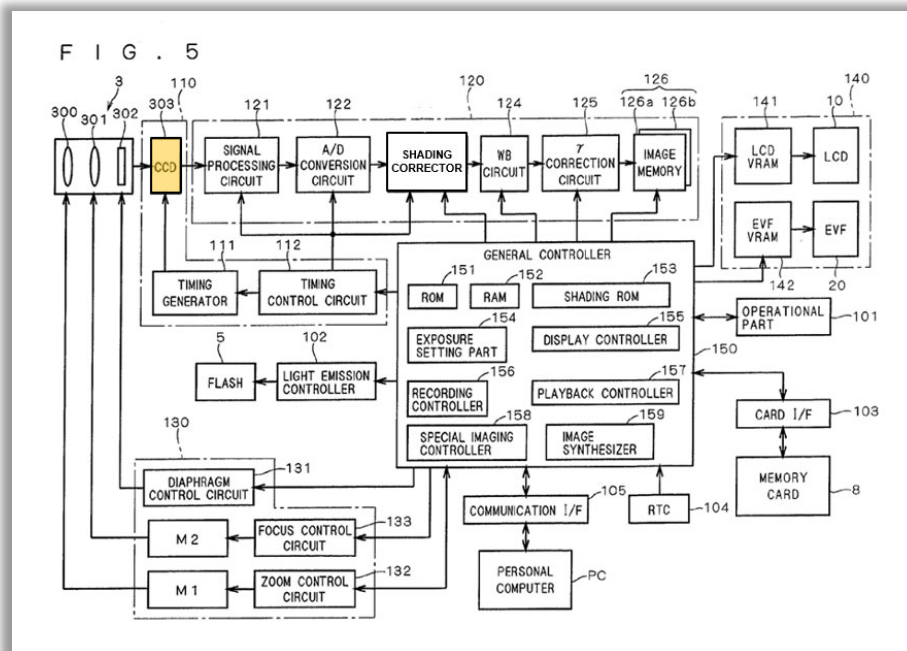
Niikawa discloses an optical lens mechanism (imaging lens 3). Ex-1003, ¶107.

[1A-3] a digital sensor,

Niikawa discloses that digital camera 1 has a digital sensor in the form of CCD 303 (orange). Ex-1005, [0067], [0077], Figs. 3, 5, Claim 8 (“an image sensor for acquiring a first image and a second image for the same subject in different timings”). The ’339 Patent teaches that a CCD is a digital sensor. Ex-1001, 2:48-51, 2:65-67, 5:6-22, 8:15-17, 13:63-66, 17:47-50, 18:25-30, 34:29-31; Ex-1003, ¶108.



Ex-1005, Fig. 3.

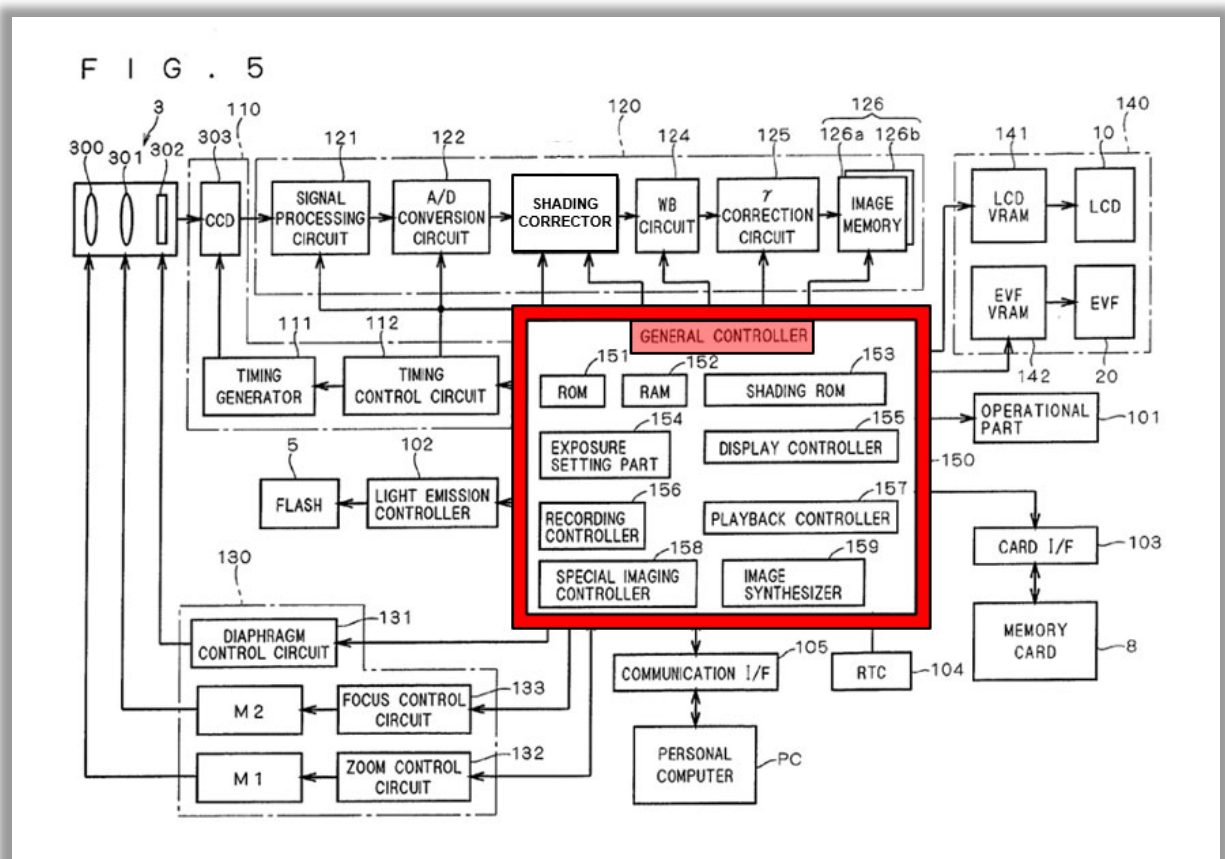


Ex-1005, Fig. 5 (with shading corrector processor).

Niikawa discloses a digital sensor (CCD 303). Ex-1003, ¶109.

[1A-4] a microprocessor,

Niikawa discloses that digital camera 1 includes general controller 150 (red), which “is implemented by a microcomputer and performs centralized control of the exposure function and playback function.” Ex-1005, [0082], [0084], [0095], Fig. 5. A POSA would have understood that a microcomputer is a microprocessor. Ex-1003, ¶110.

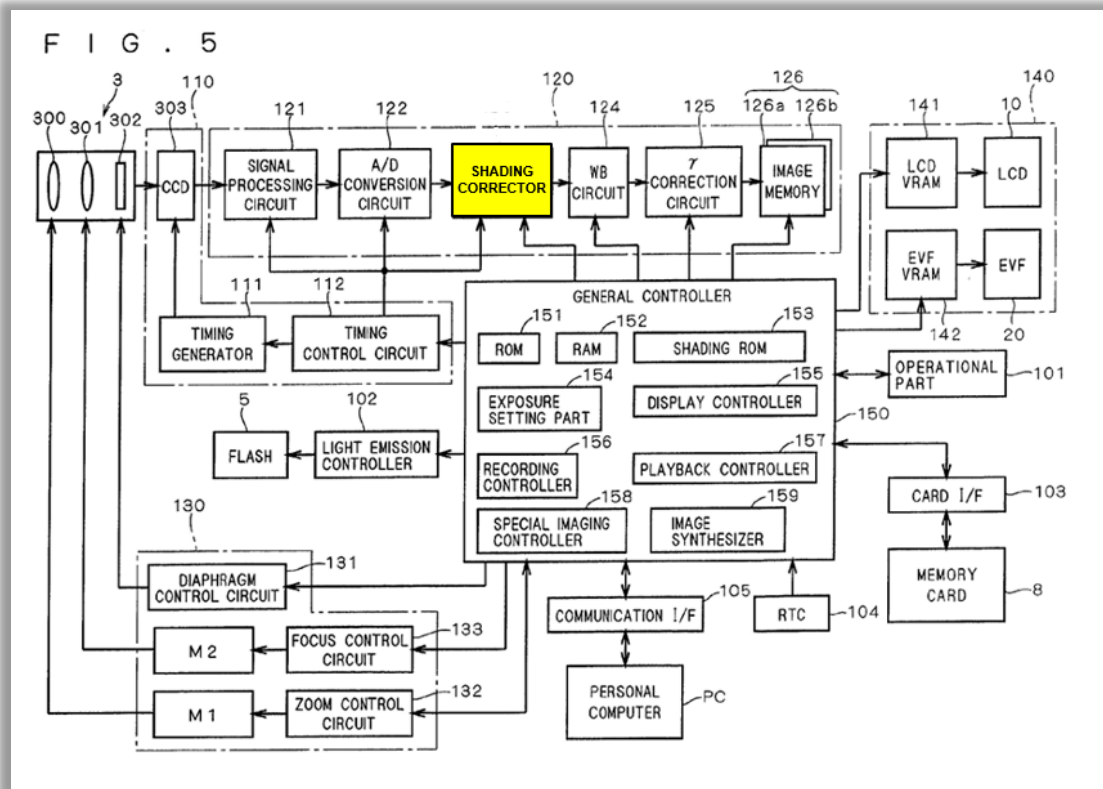


Ex-1005, Fig. 5 (with shading corrector processor).

Niikawa discloses a microprocessor (general controller 150). Ex-1003, ¶111.

[1A-5] a digital signal processor,

Niikawa discloses that digital camera 1 has a shading corrector (yellow) as part of signal processor 120 that executes “digital signal processing with respect to an image signal outputted from the CCD 303.” Ex-1005, [0079]; *see also id.*, [0077], [0092], Fig. 5, Claims 1, 2, 4, 5. Niikawa discloses that the shading corrector may be implemented as a hardware circuit, as in shading correction circuit 123, or the shading corrector may be implemented using a processor. *Id.*, [0078]-[0079], [0082], [0108], [0110], [0122], Figs. 5-6, Claims 1, 2, 4, 5. Both of these implementations are disclosed as separate from the controller. *Id.*; Ex-1003, ¶112.



Ex-1005, Fig. 5 (with shading corrector processor).

To the extent the shading correction circuit implementation of Niikawa does not explicitly disclose a digital signal processor, a POSA would have been motivated to replace shading correction circuit 123 with a processor in view of Niikawa's own claims. Claims 2 and 5 of Niikawa recite that the shading corrector of Niikawa claim 1 could either be a hardware circuit or a processor. Ex-1005, Claims 1, 2, 4, 5. A POSA would have been motivated to make this modification because a processor provides known advantages where a programmable upgrade in processing function (such as image optimization) may be desirable. Ex-1003, ¶113; *see also* Ex-1006, [0023], [0026]-[0027], [0029], [0035], Fig. 1 (disclosing a CPU, an RPU/DSP, and an LSI/ASIC for correcting aberrations).

A POSA would have been further motivated to make this modification because it would have been a simple substitution of one known element (shading correction circuit 123) for another (processor) yielding predictable results (shading correction). Ex-1003, ¶114.

A reasonable expectation of success existed for implementing this combination because shading correction with a processor performing a multiplication operation would work the same as shading correction with a hardware multiplier. *Id.*, ¶115.

Niikawa discloses a digital signal processor (shading corrector with a processor). *Id.*, ¶116.

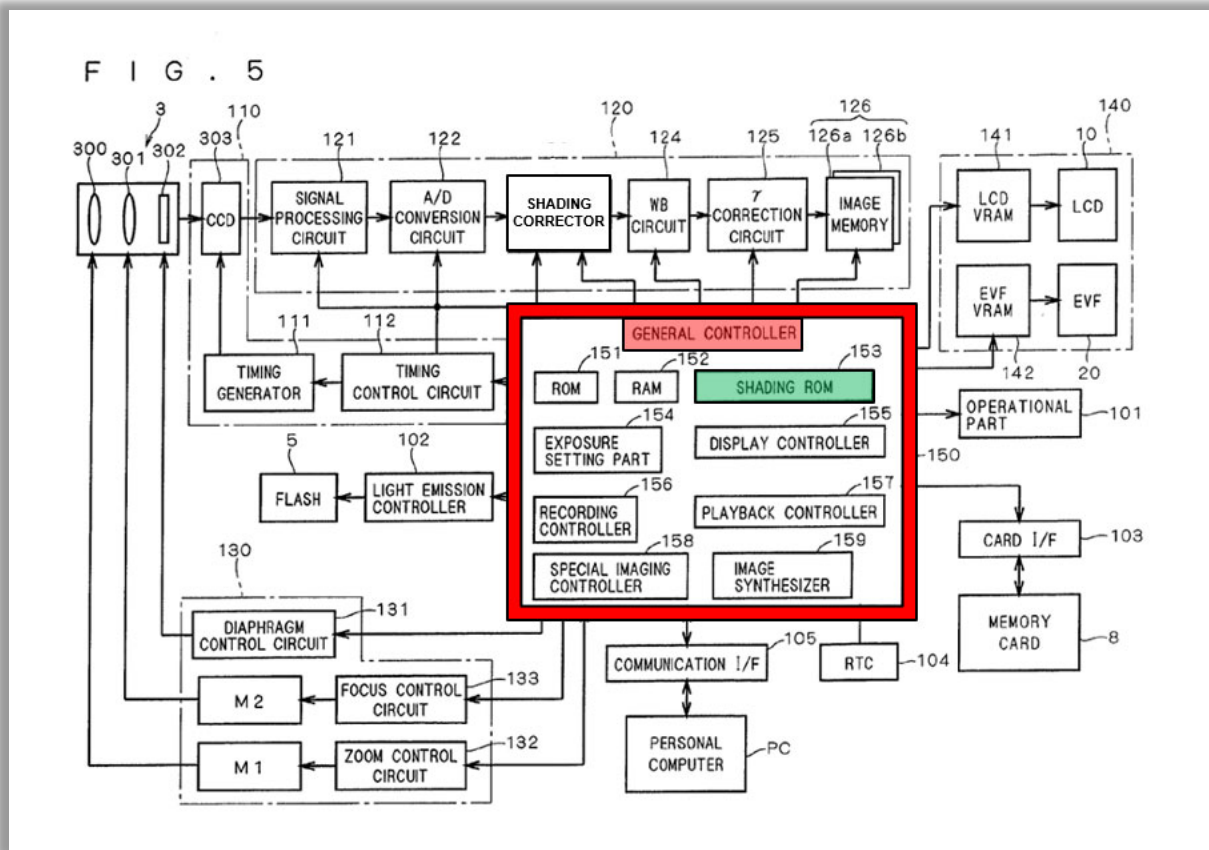
[1A-6] system software,

Niikawa discloses that general controller 150 has ROM 151 which stores programs for processing and controlling functions and components of digital camera 1. Ex-1005, [0096], *see also id.*, [0022] (“the present invention is directed to a program product containing a program for executing an image processing.”). The ’339 Patent describes “processing software” as “stored in either a microprocessor or an ASIC.” Ex-1001, 21:67-22:1. A POSA would have understood that the programs stored in ROM 151 were system software. Ex-1003, ¶117.

Niikawa discloses system software (programs stored in ROM 151). *Id.*, ¶118.

[1A-7] a database management system and

Niikawa discloses that general controller 150 (red) accesses and retrieves correction tables stored in shading ROM 153, i.e. the database (green). Ex-1005, [0082]-[0086], [0096], [0108] (teaching that correction tables store correction coefficients), Fig. 5. Each correction table is a matrix of inverse correction coefficients corresponding to the respective pixels of CCD 303 and the focal length and f-number at the time of imaging. *Id.*, [0083]-[0084]. A POSA would have understood that those correction tables are an example of a database. Ex-1014, 2:8-12 (“a database may be viewed as one or more tables of information”); Ex-1015, 1:36-39 (“Data records in a computer database are maintained in tables, which are a collection of rows all having the same columns.”); Ex-1003, ¶119.



Ex-1005, Fig. 5 (with shading corrector processor).

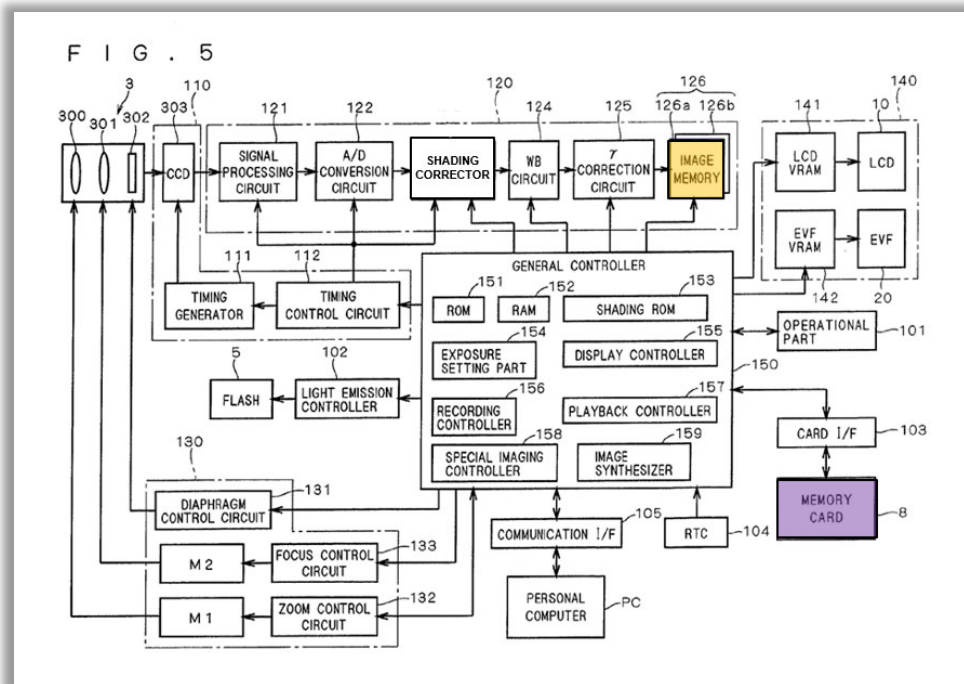
Despite other limitations in the claim reciting a “database” without antecedent basis, to the extent the claimed “database management system” (“DBMS”) is not limited to a database, Niikawa also discloses a DBMS, as disclosed in the ’339 Patent. General controller 150 includes ROM 151 which stores programs for controlling functions and components of digital camera 1. Ex-1005, [0096], Fig. 5. Those programs comprise a DBMS at least because they are software that retrieves image correction data associated with focal length and f-number at the time of imaging from the database. *Id.*, [0082]-[0086], [0096], [0101], [0108], Figs. 5, 7-8;

Ex-1003, ¶120.

Niikawa discloses a database management system (the correction tables organized in shading ROM 153/general controller 150 and the programs stored in ROM 151). *Id.*, ¶121.

[1A-8] a memory storage sub-system;

Niikawa discloses that digital camera 1 has image memory 126 (orange) and memory card 8 (purple). Ex-1005, [0016], [0066], [0087], Figs. 2, 5. After image processing, the modified digital image files are stored in image memory 126 and memory card 8. *Id.*, [0032], [0079], [0086], [0092], [0100]-[0102], [0109]-[0110], [0121], Figs. 5, 8; Ex-1003, ¶122.

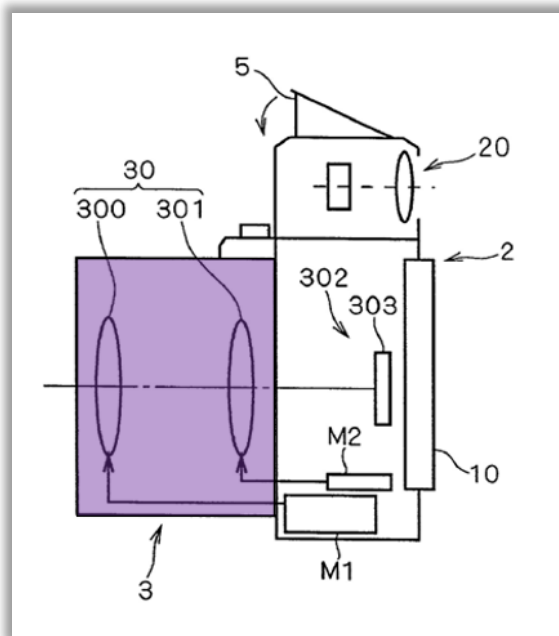


Ex-1005, Fig. 5 (with shading corrector processor).

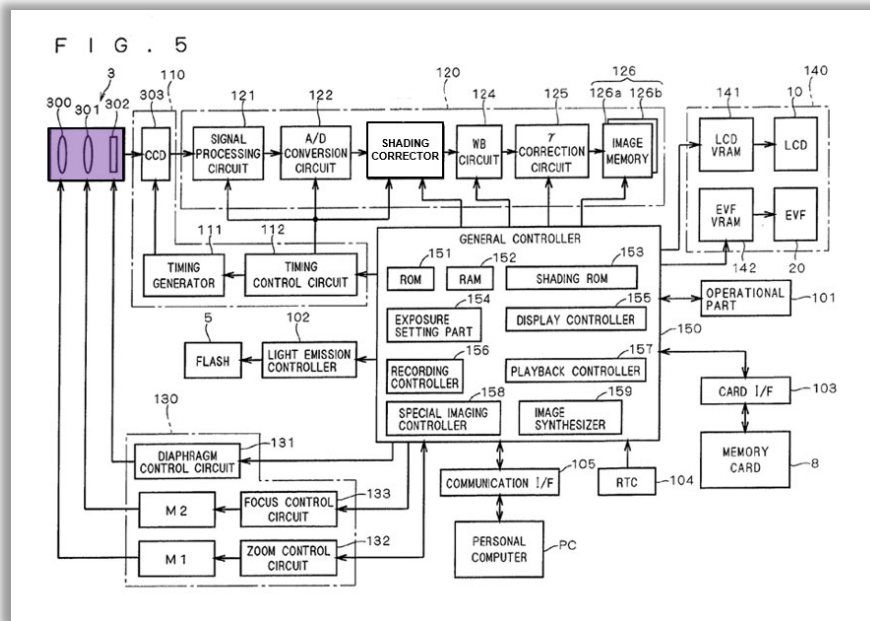
Niikawa discloses a memory storage sub-system (image memory 126 and/or memory card 8). Ex-1003, ¶123.

[1B] wherein the optical lens mechanism is a fixed focal length lens;

Niikawa discloses that digital camera 1 has an imaging lens 3 (purple), including zoom lens 300 and focus lens 301. Ex-1005, [0066], [0067], [0076], [0089], Figs. 3, 5; Ex-1003, ¶124.



Ex-1005, Fig. 3.



Ex-1005, Fig. 5 (with shading corrector processor).

Niikawa discloses that the user can adjust zoom lens 300 to different fixed focal lengths. Ex-1005, [0058] (describing settings for different focal lengths), [0067], [0072], [0083]-[0084], [0089]-[0090], [0108]; *see also* Ex-1001, 26:18-19 (“This is as if each zoom lens contains a combination of multiple lenses of specific focal lengths.”); Ex-1016, claim 9 (“wherein the [zoom] lens focal length alternates from specific fixed focal length lens settings in a succession of steps”); Ex-1003, ¶125.

To the extent not expressly disclosed, a POSA would have been motivated to replace imaging lens 3 of Niikawa with a fixed focal length lens. Niikawa discloses that imaging lens 3 is detachable. Ex-1005, [0066]. It was well known to use either a fixed focal length lens or a zoom lens with a camera, including with a camera having detachable lenses, depending on the situation. Ex-1003, ¶ 126. Correcting aberrations

in fixed focal length lenses was also well known. Ex-1017, 3:66-5 (disclosing correcting aberrations in fixed focal length lenses); Ex-1018, 40:9-24, 40:44-47 (same); Ex-1003, ¶127. Niikawa also discloses identifying correction tables to correct shading aberrations in the captured image data using optical conditions such as focal length and f-number at the time of imaging. Ex-1005, [0084], [0101], [0108], Figs. 7, 8. The tables for zoom and fixed focal length lenses would be the same, except zoom lenses require additional tables to account for each focal length. Ex-1018, 40:44-47 (“If the camera used to take the image is a fixed focal length type which has no zooming capability, the focal length may be acquired from the information for identifying the lens type (or the camera model)”); Ex-1013, 6:22-40 (explaining that correcting aberrations for zoom lenses requires storing corrections “based on the lens characteristics corresponding to each focal length”); Ex-1003, ¶¶126-27.

During prosecution, PO stated, “[o]ne must conceive of the problem of optical aberrations of a zoom lens as a set of different types of fixed focal length lenses.” Ex-1002, 121. Moreover, during the prosecution of the related ’805 Patent, PO stated that “[s]ince the invention that includes the main allowed claims focuses on the filtration of images and image components, the distinction between fixed focal length lenses and zoom lenses are less relevant than the primary issue of filtration. Ex-1019, 161. PO explained that “[f]ixed and zoom lenses are merely different animals of the species and share numerous components as disclosed in the original disclosure[.]” *Id.*

The '339 Patent likewise admits that the different aberrations between zoom and fixed focal length lenses were known. Ex-1001, 4:25-38; Ex-1003, ¶128.

A POSA would have been further motivated to replace detachable lens 3 with a fixed focal length lens because it would have been a simple substitution of one known element (lens 3) for another (a fixed focal length lens) to obtain predictable results (correcting aberrations based on focal length). *Id.*, ¶129.

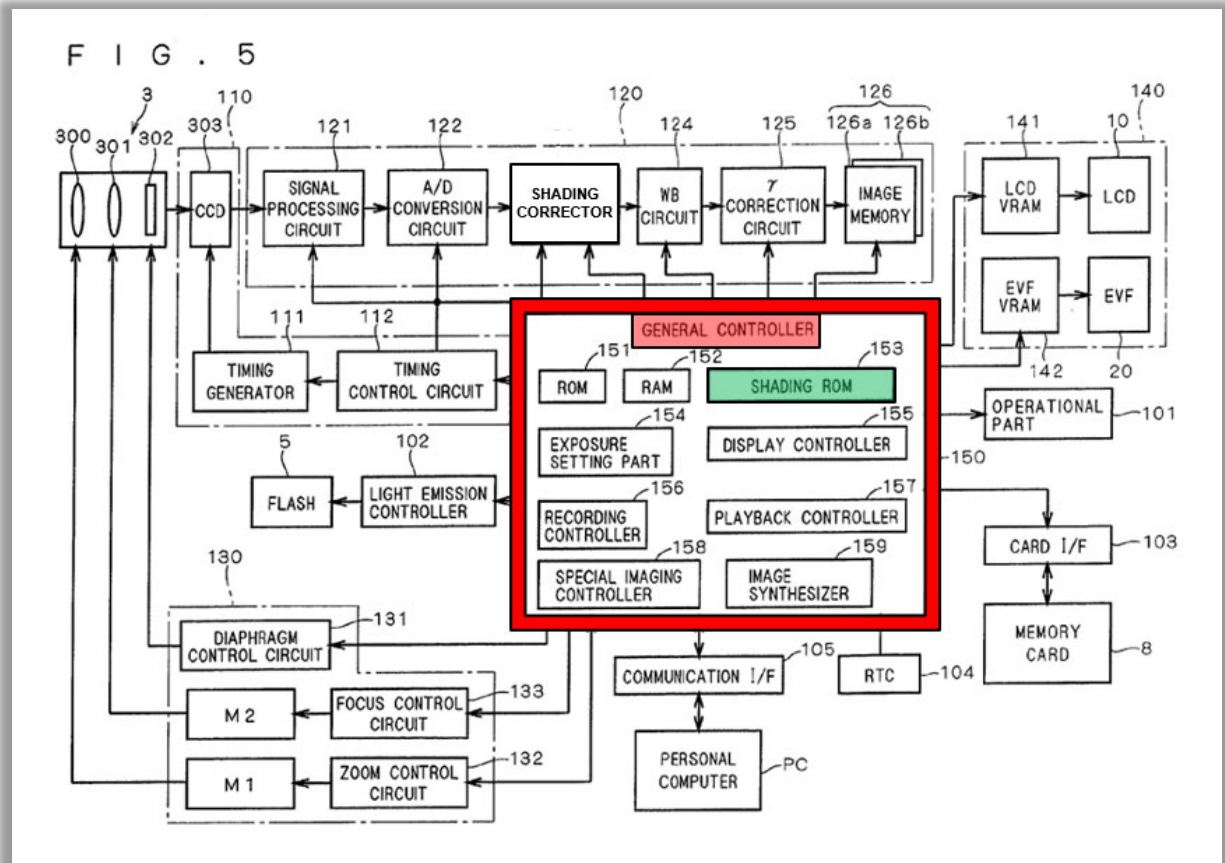
A POSA would have had a reasonable expectation of success of implementing this combination because digital cameras with fixed focal length lenses were commercially available, Niikawa's aberration correction solution would apply similarly to both zoom and fixed lenses, and Niikawa teaches detachable lenses allowing for different lenses. *Id.*, ¶130.

Niikawa discloses and renders obvious wherein the optical lens mechanism (imaging lens 3) is a fixed focal length lens. *Id.*, ¶131.

[1C] wherein a microprocessor uses system software to identify at least one optical aberration by accessing the database;

Niikawa discloses that general controller 150 (red) uses the programs stored in ROM 151 to identify one of a plurality of correction tables from the shading ROM 153, the database (green), according to optical conditions, such as focal length and f-number at the time of imaging. Ex-1005, [0082]-[0085], [0096], [0101], [0108], Figs. 5, 7, 8. The correction tables in shading ROM 153 include the inverse of

correction coefficients that correspond to specific optical aberrations and are used to correct those aberrations. *Id.*, [0082]-[0085]; Ex-1003, ¶132.



Ex-1005, Fig. 5 (with shading corrector processor).

The lens optical conditions signify the aberrations in the lens. Specifically, a lens having an adjustable aperture value would have different shading characteristics, e.g., different vignetting, at each aperture value. The focal length of the lens affects vignetting too. Ex-1003, ¶133. The '339 Patent teaches that aberrations change at different focal lengths. Ex-1001, 26:7-9. To the extent “optical image aberrations” in the preamble requires multiple aberrations, the

aberrations at each aperture value (or aperture and focal length pair) are multiple aberrations. Thus, by identifying the optical conditions at the time of imaging, general controller 150 identifies the specific optical aberration to correct in the database. Ex-1003, ¶133.

To the extent not expressly disclosed, a POSA would have been motivated to modify the programs stored in general controller 150 to identify both specific shading aberrations and other types of aberrations. Enomoto discloses storing information about the lens characteristics in a storing section, and that information may be either correction functions/equations and/or coefficients for correcting aberrations such as lateral chromatic aberration and distortion. Ex-1008, 14:4-49. Processor 14 in Enomoto includes a CPU used to identify that information from the storing section and send it to an aberration correcting part 56 for correcting those aberrations by digital image processing. *Id.*, Abstract, 11:60-12:9, 12:33-40, 13:6-18, 14:4-24, Fig. 2; Ex-1003, ¶134.

A POSA would have been motivated to use the programs stored in general controller 150 (like the CPU of processor 14) to identify both shading and other types of aberrations in shading ROM 153 (like in lens characteristics data supply subsection 60) to improve image quality. Ex-1003, ¶135. Niikawa states that the purpose of its invention is to improve image quality and graphic effect. Ex-1005, [0003]. Enomoto likewise teaches consistently outputting high quality images free from color-

mismatch, distortion, uneven brightness, and blurring. Ex-1008, Abstract, 3:62-4:4, 13:13-21. A POSA would have been motivated to modify the programs stored in general controller 150 to identify multiple types of aberrations because each aberration identified and corrected would further improve the image quality. Ex-1003, ¶135.

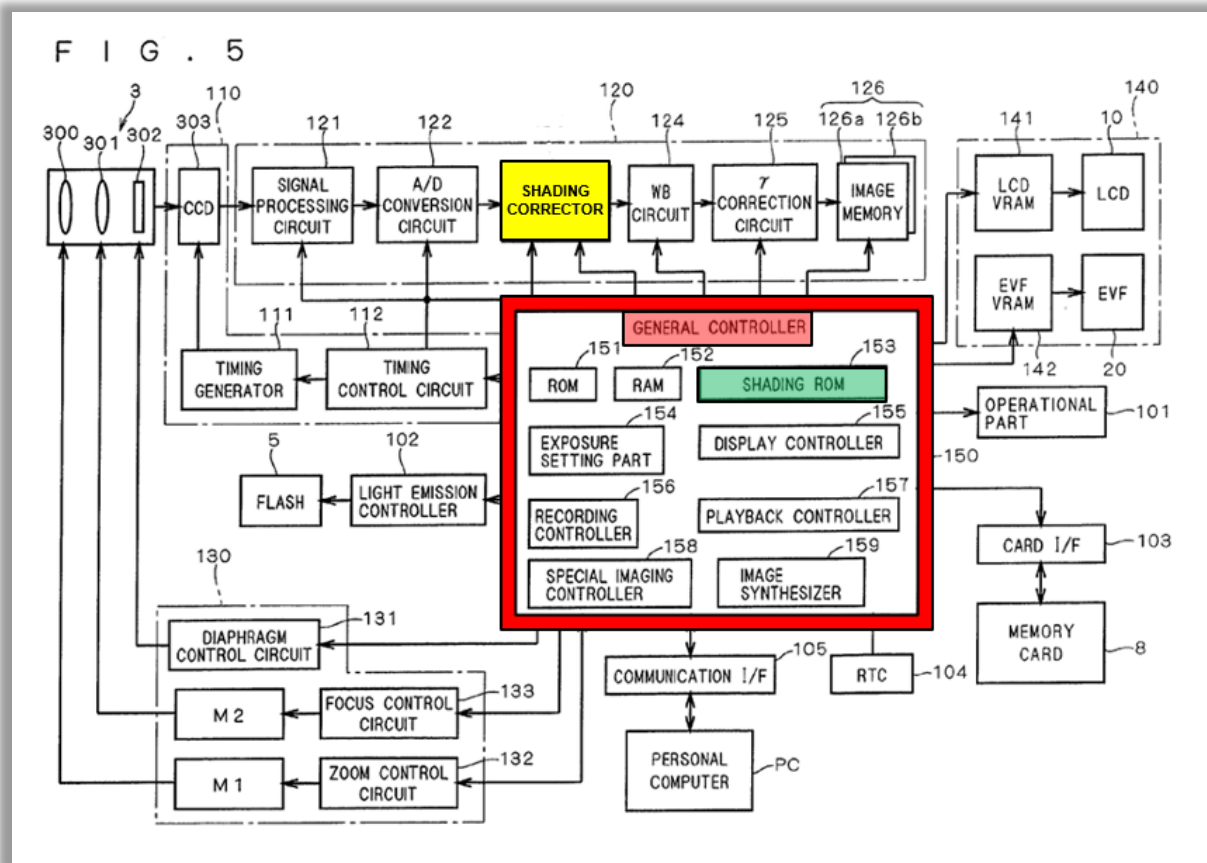
A POSA would have been motivated to modify the programs stored in general controller 150 to identify both shading and other types of aberrations because it would have used a known technique (identifying multiple types of aberrations) to improve similar devices (general controller 150 and the CPU of processor 14) in the same way (correcting multiple aberrations). *Id.*, ¶136.

A reasonable expectation of success existed as Enomoto discloses that processor 14 identifies multiple aberrations, which the general controller 150 similarly does for shading aberrations, so the modification to identify different types of aberrations using general controller 150 would have been straightforward and within the skill of a POSA. *Id.*, ¶137.

Niikawa discloses and Niikawa in view of Enomoto render obvious wherein a microprocessor (general controller 150) uses system software (programs stored in ROM 151) to identify at least one optical aberration (a shading aberration for a specific focal length and f-number/or other types of aberrations) by accessing the database (correction tables stored in ROM 153). *Id.*, ¶138.

[1D] wherein the microprocessor uses the database to identify at least one algorithm to use to correct the at least one optical aberration;

Niikawa discloses that general controller 150 (red) identifies inverse correction coefficients in a correction table from shading ROM 153 (green) according to optical conditions, such as lens type, focal length and f-number at the time of imaging. Ex-1005, [0082]-[0085], [0096], [0101], [0108], Figs. 5, 7, 8. General controller 150 sends those correction coefficients to the shading corrector (yellow) to correct shading based on the optical condition. *Id.*, [0082]-[0085], [0108]. The shading corrector may be implemented with a processor for performing an operational process, such as multiplication, on image data using said coefficients. *Id.*, Abstract, [0082]-[0083], [0108], Claim 5. By identifying the coefficients to send to, and be used as part of, the shading corrector, general controller 150 also identifies the operational process (e.g., the multiplication function) for the shading corrector to perform. Ex-1003, ¶139.



Ex-1005, Fig. 5 (with shading corrector processor).

To the extent not expressly disclosed, a POSA would have been motivated to modify the programs stored in general controller 150 to identify the correction algorithms in the database for each type of aberration. As explained in [1C], a POSA would have been motivated to modify the programs stored in general controller 150 to identify multiple types of aberrations in view of Enomoto. Enomoto also discloses that the CPU identifies correction functions/equations in the storing section and sends them to aberration correcting part 56 to apply. Ex-1008, Abstract, 11:60-12:9, 12:33-40, 13:6-18, 14:4-49, Fig. 2. Because the general controller 150 identifies different

types of aberrations, a POSA would have been motivated to modify general controller 150 (like the CPU of processor 14) to identify corresponding correction algorithms in shading ROM 153 (like in the storing section) and send it to the processor of the shading corrector (like aberration correcting part 56) as well. Ex-1003, ¶¶140-41.

A POSA would have been motivated to store the algorithms in shading ROM 153 so that the user could update them after purchasing the camera. Ex-1005, [0096] (disclosing that additional program data can be read out and installed in ROM 151 of general controller 150); Ex-1020, 4:63-5:1, 5:31-40, 6:27-32, 7:51-57 (disclosing that control processor 20 can add software updates to a digital camera after its initial purchase and store them in an algorithm memory 28 for use by DSP 22, including modifying and updating aberration correction algorithms); Ex-1021, [005]-[008], [012]-[018], Figs. 2, 3, Claim 1 (disclosing an in-camera control unit to derive aberration correction functions using characteristics of the input device, like “distance between the calibration graphic 26 and the lens 11” and “brightness,” then store the functions in memory to later use to correct aberrations), [038] (disclosing that the calibration program used to derive correction functions can be recalibrated by a specialty store or manufacturer after manufacturing the camera); Ex-1003, ¶142.

A POSA would have been further motivated to modify the programs stored in general controller 150 because it would have used a known technique (identifying algorithms in a database) to improve a similar device (general controller 150 and the

CPU of processor 14) in the same way (correcting different types of aberrations). *Id.*, ¶143.

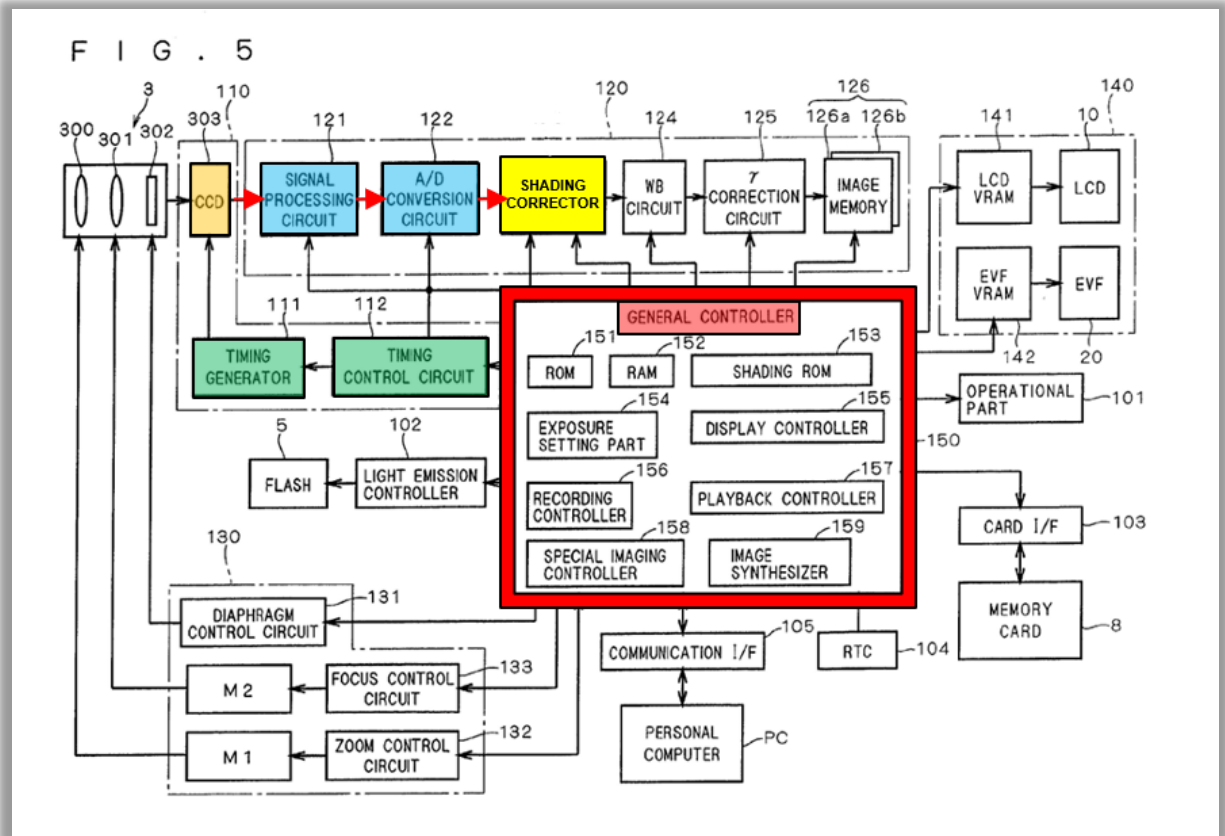
A POSA would have had a reasonable expectation of success of implementing this combination because identifying and sending the algorithm by accessing shading ROM 153 would work the same way as identifying and sending the coefficients by accessing shading ROM 153. *Id.*, ¶144.

Niikawa discloses and Niikawa in view of Enomoto render obvious wherein the microprocessor (general controller 150) uses the database (correction tables stored in ROM 153) to identify at least one algorithm (multiplication using correction coefficients/or other aberration correction algorithms) to use to correct the at least one optical aberration (a shading aberration for a specific focal length and f-number/or other types of aberrations). *Id.*, ¶145.

[1E] wherein when the image file is captured by the digital sensor the digital file is forwarded to the digital signal processor;

Niikawa discloses that the data captured by CCD 303 (orange) is forwarded to signal processor 120 using a readout control signal inputted from the timing generator 111 (green) controlled by general controller 150 (red). Ex-1005, [0077]-[0079], [0096], [0107]-[0108], Fig. 5. Using signals controlled by general controller 150, signal processor circuit 121 and A/D conversion circuit 122 (blue) process and convert the analog data into digital data and forward that data to the shading

corrector (yellow), as depicted by the red arrows below. *Id.*, [0080]-[0081], [0107], [0110]; Ex-1003, ¶146.



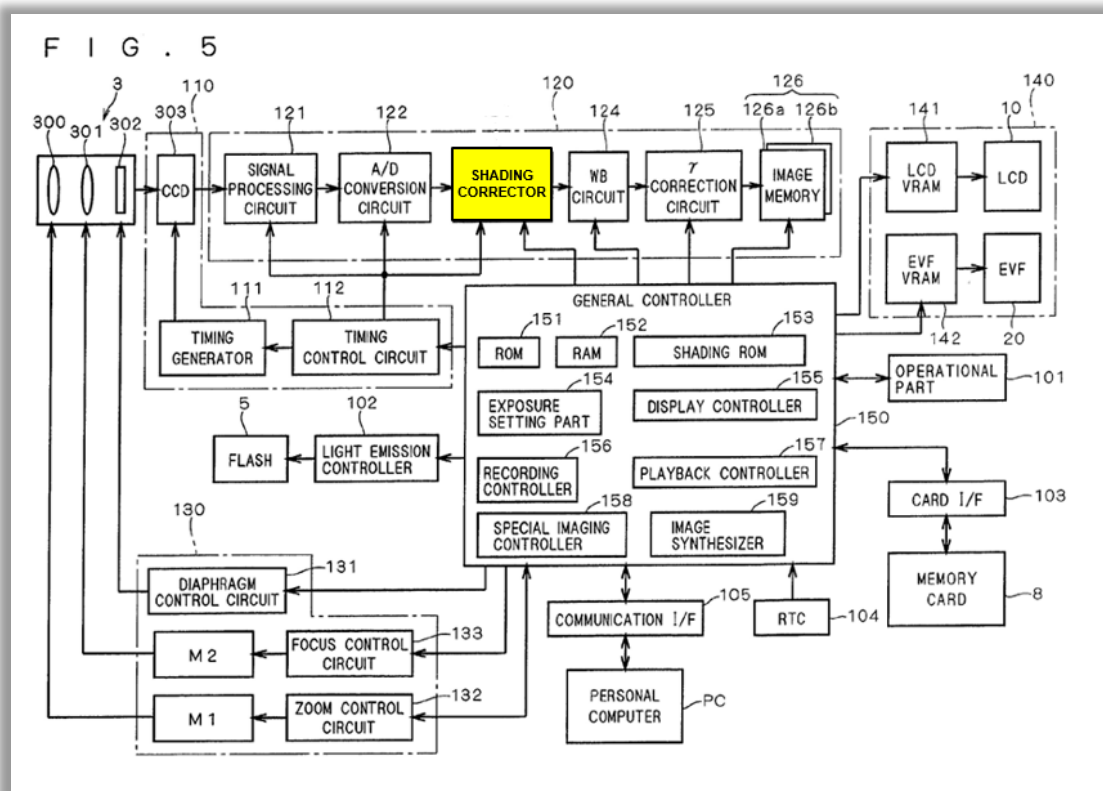
Ex-1005, Fig. 5 (with shading corrector processor).

Niikawa discloses wherein when the image file (image data) is captured by the digital sensor (CCD 303) the digital file is forwarded to the digital signal processor (shading corrector). Ex-1003, ¶147.

[1F] wherein the image file with the at least one optical aberration is corrected by applying digital filtration by using at least one algorithm in the digital signal processor; and

Niikawa discloses that the shading corrector uses the correction coefficients

sent from general controller 150 to correct shading based on the optical condition. Ex-1005, [0082]-[0085], [0108]. The shading corrector uses the multiplication function (the algorithm) to multiply the received image data by the correction coefficients to correct the shading aberration. *Id.*, Abstract, [0082]-[0083], [0107]-[0110], Fig. 6, Claim 5; Ex-1003, ¶148.



Ex-1005, Fig. 5 (with shading corrector processor).

A decrease in light farther away from a center of a lens is known as vignetting. Ex-1003, ¶149. The '339 Patent discloses that vignetting or shading correction is a form of filtration. Ex-1001, 31:15-24, 31:31-37. A POSA would have also

understood that multiplying digital image data with correction coefficients for shading correction is a form of digital filtration. Ex-1003, ¶149.

Niikawa discloses and Niikawa in view of Enomoto render obvious wherein the image file with the at least one optical aberration (a shading aberration for a specific focal length and f-number/or other types of aberrations) is corrected by applying digital filtration by using at least one algorithm (multiplication using correction coefficients/or other aberration correction algorithms) in the digital signal processor (shading corrector). *Id.*, ¶150.

[1G] wherein the modified digital file consisting of the digital data optimized from the at least one optical aberration that are corrected from the original optical image is stored in memory.

Niikawa discloses this limitation as explained in [1A-8]. Additionally, after correction, signal processor 120 further processes the digital data through white balance correction and γ correction before storing the modified data in memory (*i.e.*, image memory 126 and/or memory card 8). Ex-1005, [0079], [0086], [0109]-[0110]; Ex-1003, ¶151.

Niikawa discloses wherein the modified digital file consisting of the digital data optimized from the at least one optical aberration (shading aberrations for a specific lens type, focal length, and f-number) that are corrected from the original optical image (image data from CCD 303) is stored in memory (image memory 126 and/or memory card 8). Ex-1003, ¶152.

Accordingly, claim 1 would have been obvious over (a) Niikawa and (b) Niikawa in view of Enomoto. Ex-1003, ¶153.

2. Claim 2

[2] The system of claim 1: wherein the optical aberrations include at least one of spherical, comatic, lens distortion, astigmatism, curvature of field, pin cushion, barrel distortion, chromatic aberrations, scattered light, red eye, dust and/or flare types of optical aberrations.

Niikawa in view of Enomoto render obvious this limitation as explained in [1C]. Specifically, Enomoto teaches correcting both chromatic aberrations and lens distortions. Ex-1003, ¶154.

Accordingly, claim 2 would have been obvious over (b) Niikawa in view of Enomoto. *Id.*, ¶155.

3. Claim 3

The system of claim 1:

[3A] wherein the optical aberration is vignetting;

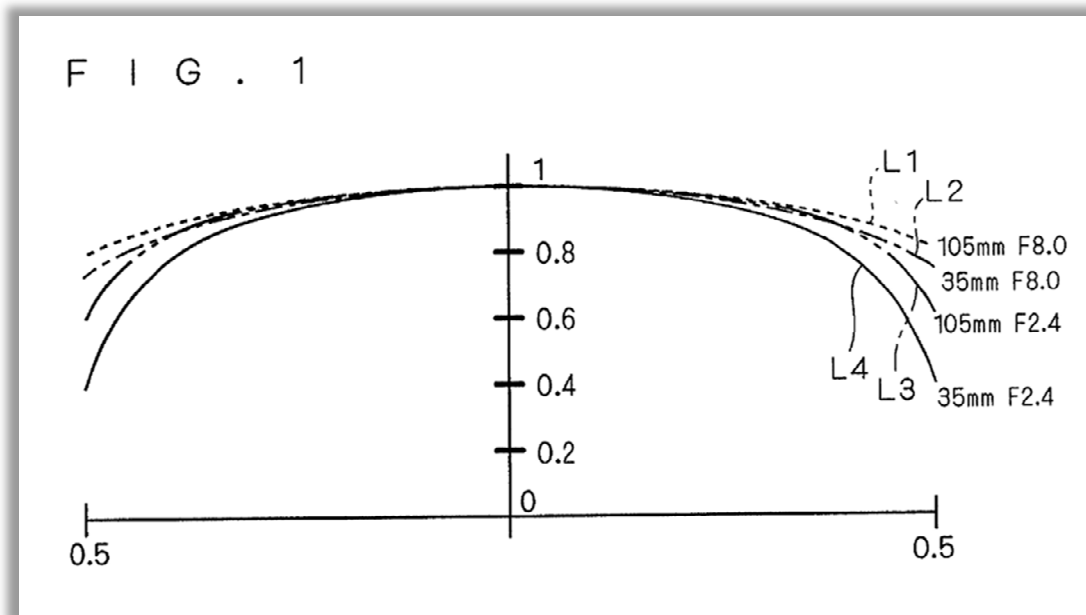
Niikawa discloses correcting the optical aberration of shading. Ex-1005, Abstract, [0014], [0056]-[0060] (describing shading). The shading corrector uses the correction coefficients sent from general controller 150 to correct shading based on the optical condition. *Id.*, [0082]-[0085], [0108]. Niikawa describes shading aberrations as the level of image data decreasing as the distance from the center of the image increases. *Id.*, [0012], [0056], [0059], Fig. 1. A POSA would have understood this to be vignetting. Ex-1003, ¶156; [1F].

Niikawa discloses wherein the optical aberration is vignetting. *Id.*, ¶157.

[3B] wherein the digital signal processor applies neutral density filtration from one third of a stop to three stops in the center of the image and/or wherein the digital signal processor applies an algorithm to lighten the corners of the image or the digital signal processor applies both neutral density filtration in the image center and/or an algorithm to lighten the corners of the image; and

This claim element is written in the alternative, requiring only one of the potential sub-elements to be applied by the DSP. Ex-1003, ¶158.

Niikawa discloses that the shading corrector lightens the “periphery” or corners of the image by multiplying the shading curve by its inverse. Ex-1005, [0082]-[0083], Figs. 1, 7 (disclosing a correction table). As seen in Figure 1, “the closer to the periphery the image data exists, the more the image is likely to be influenced by shading,” as represented by the curves as they move closer to 0.5 on the horizontal axis, which represents the distance from the optical axis of the image data. *Id.* [0057], [0059], Fig. 1. “[B]y subjecting every pixel data to the multiplication by the inverse of the correction coefficient (coefficient process), the shading can be corrected.” *Id.* [0083]. The shading corrector thereby lightens the corners of the image by applying the multiplication algorithm. Ex-1003, ¶159.



Ex-1005, Fig. 1.

Niikawa discloses wherein the digital signal processor (shading corrector) applies an algorithm to lighten the corners of the image (multiplication function). Ex-1003, ¶160.

[3C] wherein the image exposure is optimized to correct the vignetting.

Niikawa discloses that the shading corrector corrects vignetting by multiplying the image data with correction coefficients corresponding to optical conditions such as focal length and f-number. Ex-1005, [0058], [0060], [0074], [0082]-[0084], [0089]-[0090], [0106], [0108]-[0110], Figs. 1, 7; Ex-1003, ¶161.

Niikawa discloses wherein the image exposure is optimized to correct the vignetting. *Id.*, ¶162.

Accordingly, claim 3 would have been obvious over (a) Niikawa and (b) Niikawa in view of Enomoto. Ex-1003, ¶163.

4. Claim 5

The system of claim 1:

[5A] wherein each lens type is registered in the camera database;

Niikawa discloses that digital camera 1 has a detachable lens and general controller 150 that accesses and retrieves correction tables from shading ROM 153. Ex-1005, [0066], [0082]-[0086], [0096], [0108], Fig. 5. Shading ROM 153 stores a plurality of correction tables for different parameters which are the optical conditions such as focal length and f-number at the time of imaging. *Id.*, [0084]. By storing correction coefficients corresponding to different focal positions in shading ROM 153, it would also register the different lens types. Ex-1003, ¶164.

To the extent not expressly disclosed, a POSA would have been motivated to modify shading ROM 153 to register lens types to further identify aberrations. As explained in [1C], a POSA would have been motivated to modify the programs stored in general controller 150 to identify multiple types of aberrations in view of Enomoto. Enomoto discloses storing lens characteristics including the lens type in the database to identify aberration correction coefficients and/or equations. Ex-1008, Abstract, 5:63-67, 6:56-58, 13:28-39, 14:4-25. Niikawa likewise discloses using optical conditions of different kinds of lenses to identify correction

coefficients to correct shading. Ex-1005, Abstract, [0082]-[0085], [0107]-[0110], Fig. 6; Ex-1003, ¶165. A POSA thus would have been motivated to register lens types to identify different aberrations based on those lens types as well. Ex-1003, ¶¶165-67.

A POSA would have been motivated to store lens type in the database as a selection condition because it would have used a known technique (registering lens type) to improve similar devices (shading ROM 153) in the same way (using lens type as a correction table selection condition). *Id.*, ¶168. For example, a POSA would have understood that the type of lens could result in differences in chromatic aberrations and distortions, and thus different correction coefficients would be required for each. *Id.*

A reasonable expectation of success existed as Enomoto discloses that processor 14 uses lens type to identify aberrations, which the general controller 150 similarly does with optical conditions for shading aberrations, so the modification to identify aberrations using lens type would have been straightforward and within the skill of a POSA. *Id.*, ¶169.

Niikawa discloses and Niikawa in view of Enomoto render obvious wherein each lens type is registered in the camera database (correction tables stored in ROM 153). *Id.*, ¶170.

[5B] wherein the multiple optical aberrations of each lens is listed in the database;

Niikawa discloses and Niikawa in view of Enomoto render obvious this limitation as explained in [1C] and [5A]. Ex-1003, ¶171.

Niikawa discloses and Niikawa in view of Enomoto render obvious wherein the multiple optical aberrations of each lens (aberrations for each focal length and f-number/aberrations based on lens type) is listed in the database (correction tables stored in ROM 153). Ex-1003, ¶172.

[5C] wherein the filtration solutions to the lens optical aberrations are listed in the database;

Niikawa discloses and Niikawa in view of Enomoto render obvious this limitation as explained above in [1C], [1D], and [5A]. Ex-1003, ¶173.

Niikawa discloses and Niikawa in view of Enomoto render obvious wherein the filtration solutions (correction coefficients/correction functions) to the lens optical aberrations (aberrations for each focal length and f-number/aberrations based on lens type) are listed in the database (correction tables stored in ROM 153). Ex-1003, ¶174.

[5D] wherein the filtration of each lens optical aberration is applied by the digital signal processor; and

Niikawa discloses and Niikawa in view of Enomoto render obvious this limitation as explained in [1F] and [5A]. Ex-1003, ¶175.

Niikawa discloses and Niikawa in view of Enomoto render obvious wherein the filtration (correction functions using correction coefficients) of each lens optical aberration (aberrations for each focal length and f-number/ aberrations for each lens type) is applied by the digital signal processor (shading corrector). *Id.*, ¶176.

[5E] wherein after the digital signal processor applies the filtration to correct the optical aberrations the corrected digital file is forwarded to storage in memory.

See [1G]. Ex-1003, ¶177.

Accordingly, claim 5 would have been obvious over (a) Niikawa and (b) Niikawa in view of Enomoto. *Id.*, ¶178.

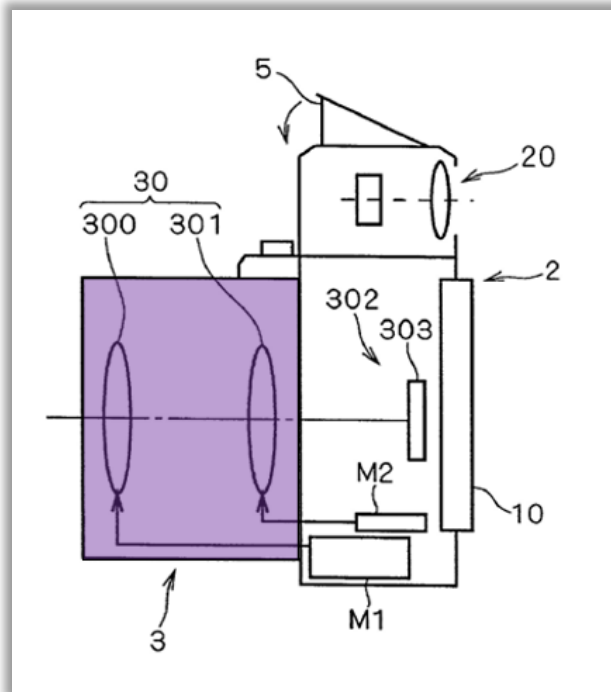
5. Independent Claim 14

[14pre]-[14A-8] A digital imaging system for correcting image aberrations comprising: a digital camera mechanism, an optical lens mechanism, a digital sensor, a microprocessor, a digital signal processor, system software, a database management system and a memory storage sub-system;

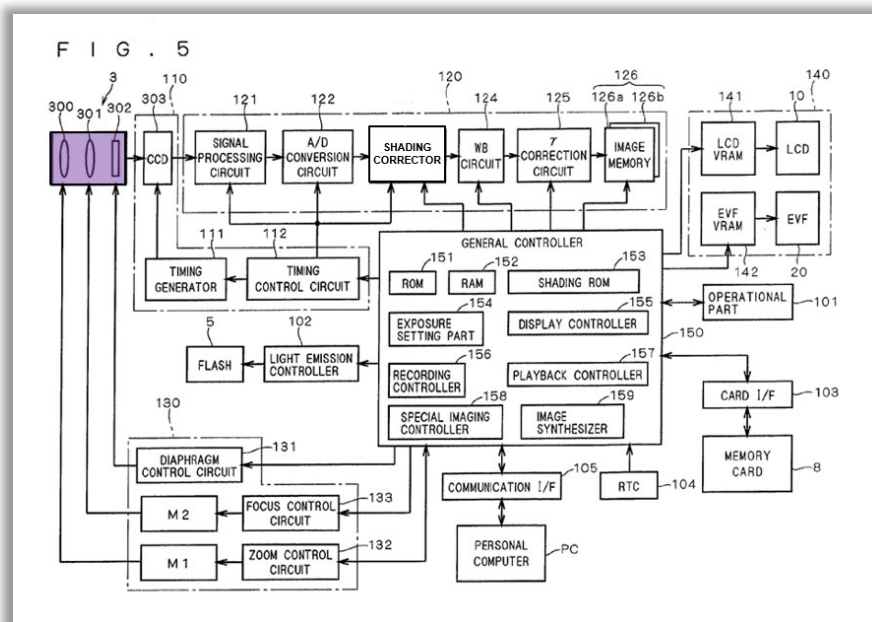
See [1pre]-[1A-8]. Ex-1003, ¶179.

[14B] wherein the optical lens mechanism is a zoom lens;

Niikawa discloses that digital camera 1 has an imaging lens 3 (purple), including zoom lens 300 and focus lens 301. Ex-1005, [0066], [0067], [0076], [0089], Figs. 3, 5; Ex-1003, ¶180.



Ex-1005, Fig. 3.



Ex-1005, Fig. 5 (with shading corrector processor).

Niikawa discloses wherein the optical lens mechanism (imaging lens 3 including zoom lens 300) is a zoom lens. Ex-1003, ¶181.

[14C] wherein the zoom lens changes focal length positions;

Niikawa discloses changing the focal length of zoom lens 300. Ex-1005, [0066], [0067], [0072], [0076], [0089]-[0090], Figs. 3, 5. Camera main body 2 has a zoom motor M1 for changing the zoom ratio of the zoom lens 300, which is controlled by the lens controller 130 function in general controller 150. *Id.* As the lens has different focal lengths positions, shading ROM 153 stores correction tables for different optical conditions, including different focal length positions. *Id.*, [0084]; Ex-1003, ¶182.

Niikawa discloses wherein the zoom lens (imaging lens 3 including zoom lens 300) changes focal length positions. *Id.*, ¶183.

[14D] wherein when the image file is captured by the digital sensor the file is forwarded to the digital signal processor and to memory;

Niikawa discloses this limitation as explained in [1E]. Additionally, Niikawa describes capturing, correcting, and storing multiple images in sequential files. Ex-1005, [0067], [0079], [0084] (describing a “plurality of correction tables for different parameters which are the optical conditions such as focal length and f-number at the time of imaging”), [0089]-[0090], [0101] (disclosing storing the image files sequentially), [0102], [0106]-[0111] (correcting aberrations of captured images based on characteristics such as focal length), Fig. 8 (showing sequential data files, each recording focal length). Ex-1003, ¶184.

Niikawa discloses wherein when the image file is captured by the digital sensor (CCD 303) the file is forwarded to the digital signal processor (shading corrector) and to memory (image memory 126 and/or memory card 8). *Id.*, ¶185.

[14E] wherein the microprocessor uses system software to access the database to identify at least one optical aberration in the image file at any focal length of a zoom lens configuration;

Niikawa discloses and Niikawa in view of Enomoto render obvious this limitation as explained in [1C]. Specifically, general controller 150 using programs stored in ROM 151 identifies correction coefficients from shading ROM 153 according to optical parameters, including the focal length of the zoom lens at the time of imaging. Ex-1005, [0084], [0101], [0108], Figs. 7, 8; Ex-1003, ¶186.

Niikawa discloses and Niikawa in view of Enomoto render obvious wherein the microprocessor (general controller 150) uses system software (the programs stored in ROM 151) to access the database (correction tables stored in ROM 153) to identify at least one optical aberration in the image file at any focal length of a zoom lens configuration (shading aberrations for a specific focal length and f-number). *Id.*, ¶187.

[14F] wherein the microprocessor accesses the database to obtain at least one filtration correction algorithm to the optical aberrations and forwards the at least one filtration algorithms to the digital signal processor;

Niikawa in view of Enomoto render obvious this limitation as explained in [1D] and [1F]. Specifically, general controller 150 would obtain the correction

coefficients and the multiplication algorithm from shading ROM 153 and forward them to the shading corrector. Ex-1003, ¶188.

Niikawa in view of Enomoto render obvious wherein the microprocessor (general controller 150) accesses the database (correction tables stored in ROM 153) to obtain at least one filtration correction algorithm (multiplication using correction coefficients/or other aberration correction algorithm) to the optical aberrations (shading aberrations for a specific focal length and f-number/or other types of aberrations) and forwards the at least one filtration algorithms to the digital signal processor (shading corrector). *Id.*, ¶189.

[14G] wherein the image file is forwarded to the digital signal processor which applies at least one filtration algorithm to optimize the image and corrects the at least one optical aberration at the specific focal length in the zoom lens configuration; and

Niikawa discloses this limitation as explained in [1E] and [1F]. Specifically, as the lens has different focal lengths positions, shading ROM 153 stores correction tables for different optical conditions, including different focal length positions. Ex-1005, [0084]. Shading corrector uses the correction coefficients sent from general controller 150 to correct aberrations based on the optical condition. *Id.*, [0082]-[0085], [0108]. The processor of the shading corrector selects the filtration algorithm to use to correct the aberration. *Id.*, Abstract, [0082]-[0083], [0107]-[0110], Fig. 6, Claim 5; Ex-1003, ¶190.

Niikawa discloses wherein the image file is forwarded to the digital signal processor (shading corrector) which applies at least one filtration algorithm (multiplication using correction coefficients and/or other aberration correction algorithm) to optimize the image and corrects the at least one optical aberration at the specific focal length in the zoom lens configuration (a shading aberration for a specific focal length and f-number/or other type of aberration). *Id.*, ¶191.

[14H] wherein the modified image file consisting of the digital data optimized from the at least one optical aberration of a specific focal length of the zoom lens that are corrected from the original optical image is stored in memory.

See [1A-8], [1G], [14G]. Ex-1003, ¶192.

Accordingly, claim 14 would have been obvious over (b) Niikawa in view of Enomoto. *Id.*, ¶193.

6. Claim 15

[15] The system of claim 14: wherein the optical aberrations include vignetting, spherical, comatic, lens distortion, chromatic aberrations, curvature of field, pin cushion, barrel distortion, scattered light, red eye, dust and/or flare types of optical aberrations.

See [3A]. Ex-1003, ¶194.

Accordingly, claim 15 would have been obvious over (b) Niikawa in view of Enomoto. *Id.*, ¶195.

7. Claim 17

[17] The system of claim 14: wherein each focal length of a zoom lens is analyzed for a different set of optical aberrations.

Niikawa discloses this limitation as explained in [1C] and [14E]. Specifically, general controller 150 identifies a specific correction table from shading ROM 153 by analyzing the focal length at the time of imaging for the zoom lens. Ex-1005, [0084], [0101], [0108], Figs. 7, 8. Each focal length corresponds with a different set of aberrations varying by f-number. Ex-1003, ¶196.

Niikawa discloses wherein each focal length of a zoom lens (imaging lens 3 including zoom lens 300) is analyzed for a different set of optical aberrations. *Id.*, ¶197.

Accordingly, claim 17 would have been obvious over (b) Niikawa in view of Enomoto. *Id.*, ¶198.

8. Claim 18

The system of claim 14:

[18A] wherein the optical aberration is vignetting;

See [3A]. Ex-1003, ¶199.

[18B] wherein the digital signal processor applies neutral density filtration from one third of a stop to three stops in the center of the image and/or wherein the digital signal processor applies an algorithm to lighten the corners of the image or the digital signal processor applies both neutral density filtration in the image center and/or an algorithm to lighten the corners of the image;

See [3B]. Ex-1003, ¶200.

[18C] and wherein the image exposure is optimized to correct the vignetting.

See [3C]. Ex-1003, ¶201.

Accordingly, claim 18 would have been obvious over (b) Niikawa in view of Enomoto. *Id.*, ¶202.

B. Grounds 2(a) and 2(b)

1. Claim 4

[4] The system of claim 1: wherein the digital signal processor applies at least one fast Fourier transform (FFT) algorithm to correct the at least one optical aberration.

The '339 Patent discloses that a FFT is an example of a digital filtration process that can be used to sharpen or soften an image. Ex-1001, 31:65-32:6. During prosecution, the Examiner took official notice that “it is old and well known in the art to have a system wherein the digital signal processor applies at least one FFT algorithm to correct the at least one optical aberration.” Ex-1002, 136, 143. PO responded that it did not claim to invent the FFT; rather, “the present invention uses the FFT as one class of algorithm to apply to specific optical or digital aberrations in image files in order to provide solutions. There is no reason not to include a powerful class of algorithm to the toolbox in order to solve the aberrations.” *Id.*, 152; *see also* Ex-1023, 1:7-11, 1:31-49, 3:1-12, 6:3-20, 9:36-67 (disclosing correcting chromatic aberrations that result in a color blurring effect using a FFT and filter that convolves the image data with weighted coefficients). Further, as

explained in [2], it would have been obvious to a POSA for the shading corrector to correct chromatic aberrations in view of Enomoto. Ex-1003, ¶204.

A POSA would have been motivated to modify the shading corrector to use a FFT to correct the chromatic aberrations. Ito discloses correcting chromatic aberrations in a digital video camera using correction circuits 4R, 4G, 4B and predetermined chromatic-aberration values. Ex-1009, ¶12. The chromatic aberration correction values are focal-length correction values for the optical lens system 1. *Id.* ¶¶13-15. Ito discloses correcting the chromatic aberration by digital signal processing using an FFT. *Id.* ¶¶17-18. A POSA would have been motivated to use the FFT of Ito to thus correct chromatic aberrations. Ex-1003, ¶205.

A POSA would have also been motivated use a FFT to accurately produce higher quality images. *Id.*, ¶206. As explained in [1C], a POSA would have been motivated to identify and correct multiple types of aberrations to further improve the quality of the images, including chromatic aberrations. Ichiyama teaches that the FFT “requires a control unit with high computing power since it is likely to require a lot of calculation processing and thus to take time, but has an advantage in enabling correction of reduced resolution by high-frequency band correction, etc.” Ex-1021, [007]. And PO confirmed that “[t]here is no reason not to include [such] a powerful class of algorithm to the toolbox in order to solve the aberrations.” Ex-1002, 152; Ex-1003, ¶206.

A POSA would have been further motivated to include the FFT algorithm for chromatic aberration correction because it would have used a known technique (a FFT) to improve similar devices (shading corrector and correction circuits 4R, 4G, 4B) in the same way (correcting optical aberrations). Ex-1003, ¶207.

A reasonable expectation of success existed too as Ito discloses that the FFT chromatic correction is applied by digital signal processing, which Niikawa similarly uses for the disclosed shading correction processes, so the updates to use FFT in Niikawa would have been straightforward and within the skill of a POSA. *Id.*, ¶208.

Niikawa in view of Ito and Niikawa in view of Ito and Enomoto render obvious wherein the digital signal processor (shading corrector) applies at least one fast Fourier transform (FFT) algorithm to correct the at least one optical aberration (chromatic aberrations). *Id.*, ¶209.

Accordingly, claim 4 would have been obvious over (a) Niikawa in view of Ito and (b) Niikawa in view of Enomoto and Ito. Ex-1003, ¶210.

2. Claim 16

[16] The system of claim 14: wherein the digital signal processor applies a fast Fourier transform (FFT) algorithm to correct optical and/or digital aberrations.

See [4]. Ex-1003, ¶211.

Accordingly, claim 16 would have been obvious over (b) Niikawa in view of Enomoto and Ito. *Id.*, ¶212.

C. Ground 3

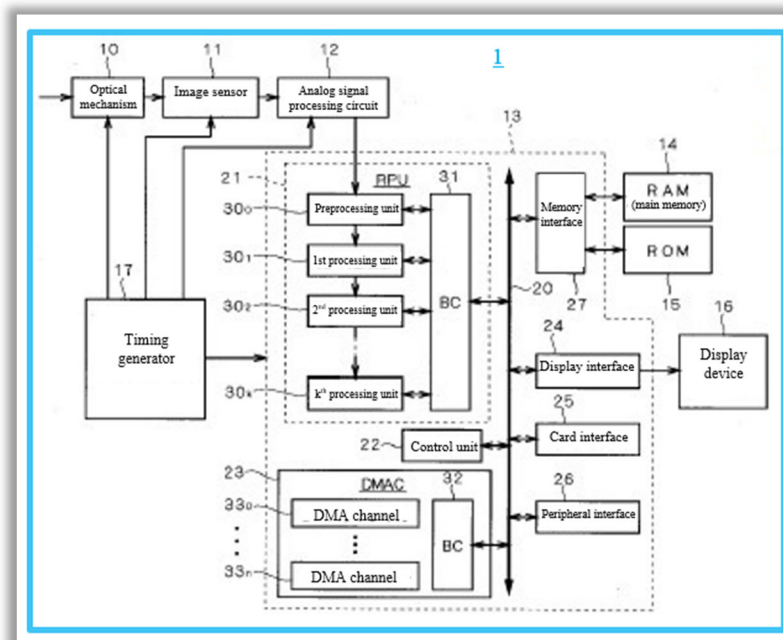
1. Independent Claim 1

[1pre]

Matsutani discloses a “digital imaging system,” such as “digital camera 1,” “for correcting optical image aberrations.” Ex-1006, [0001], [0023]-[0024], Fig. 1; Ex-1003, ¶214.

[1A-1]

Matsutani discloses a digital camera. Ex-1006, [0023], Fig. 1. Digital camera 1 includes components for imaging, processing, and displaying corrected images. *Id.*, [0023]-[0029]; Ex-1003, ¶215.

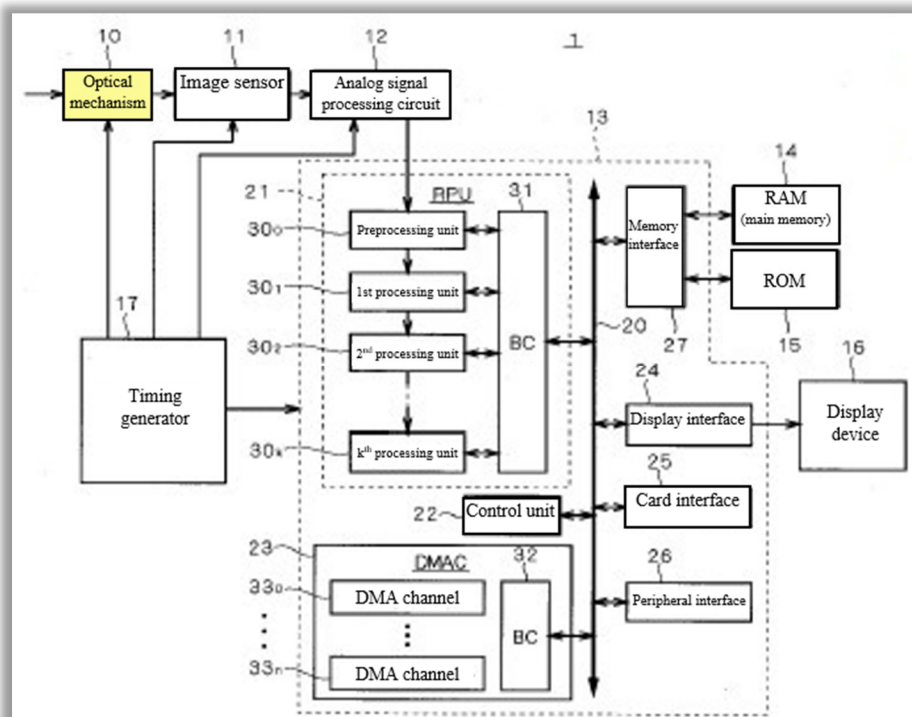


Ex-1006, Fig. 1.

[1A-2]

Matsutani discloses optical mechanism 10 (yellow) “with an optical lens.”

Ex-1006, [0024], Fig. 1; Ex-1003, ¶216.

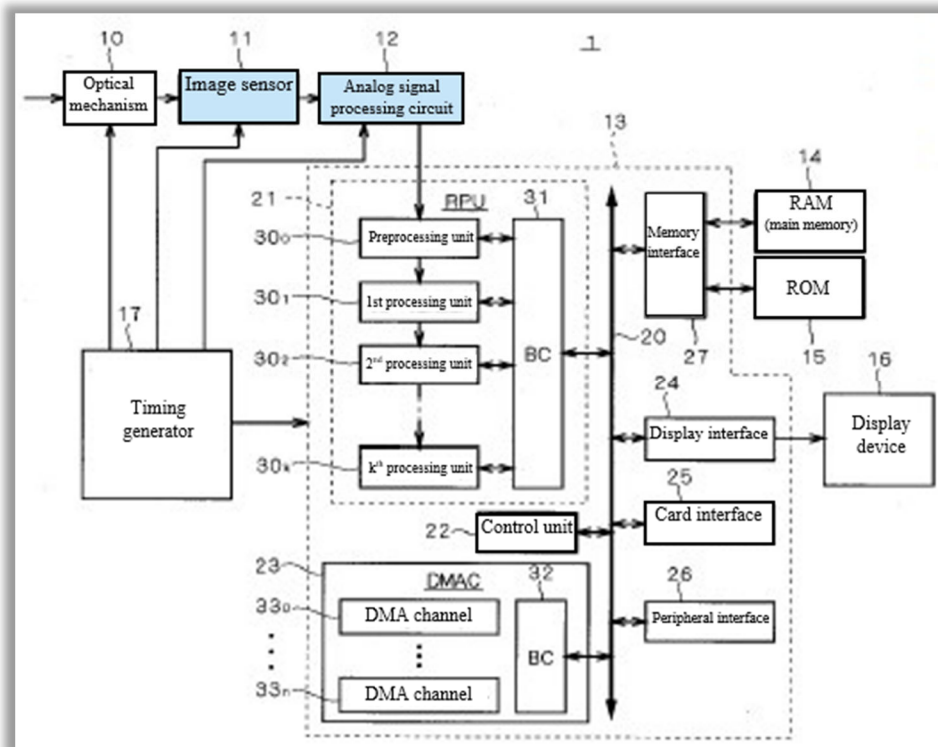


Ex-1006, Fig. 1.

[1A-3]

Matsutani discloses image sensor 11, which includes a CCD or CMOS sensor for photoelectrically converting light that has passed through the optical mechanism 10, and an analog signal processing circuit 12, which converts analog image signals to digital image signals. Ex-1006, [0023]-[0024], Fig. 1 (blue). The '339 Patent identifies a CCD as a “digital sensor[]” in which “photons are recorded by electrically charged pixels.” Ex-1001, 14:1-3; *id.*, 2:43-51, 17:47-50, 31:10-12 (analog-to-digital

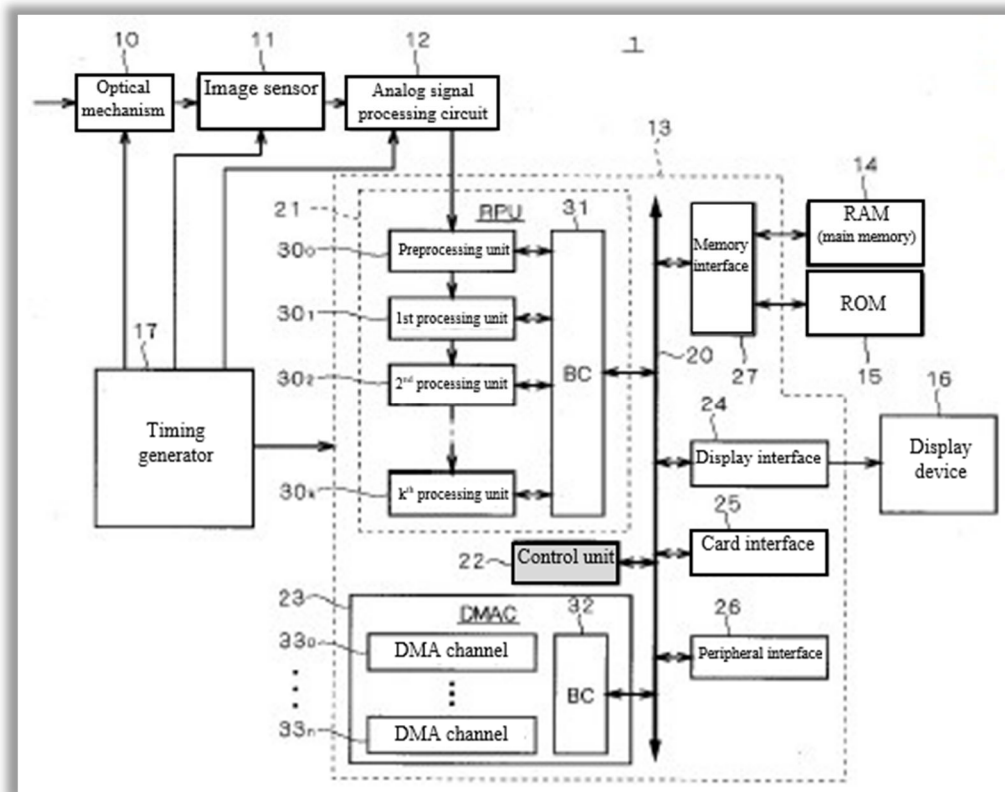
converter (“ADC”) 210 digitizes analog signal from CCD), 8:43 (describing analog-to-digital (“A/D”) conversion process), 29:39 (same), Fig. 2 (ADC 210); Ex-1003, ¶217.



Ex-1006, Fig. 1.

[1A-4]

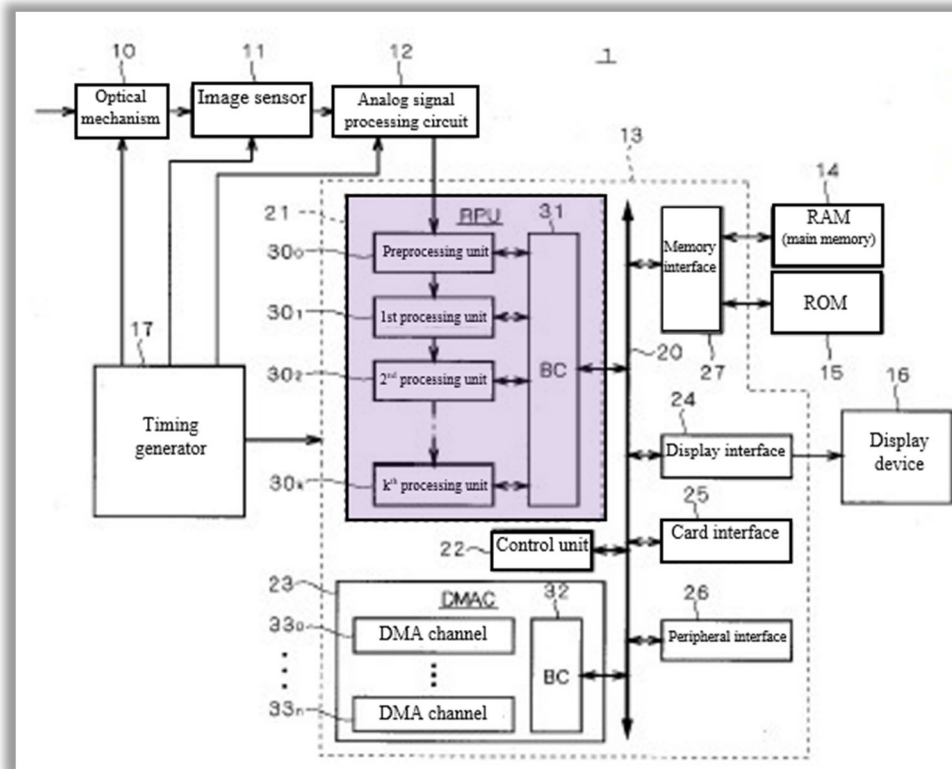
Matsutani discloses a CPU included in control unit 22. Control unit 22 has a built-in CPU, and executes a program loaded from ROM 15 to perform control processing for controlling each processing block in real-time processing circuit (“RPU”) 21, as well as image processing, etc. Ex-1006, [0026]-[0027], Fig. 1 (gray). A CPU is a microprocessor. Ex-1003, ¶218.



Ex-1006, Fig. 1.

[1A-5]

Matsutani discloses that digital camera 1 has RPU 21 that performs real-time image processing of the digital image signal input from the analog signal processing circuit 12. Ex-1006, [0029]. RPU 21 includes a filtering unit 30₂ that performs a convolution operation (product-sum operation) in which data at each point is multiplied by the filter coefficients and the results are summed. *Id.*, [0033]-[0039], Formula 1 [0043], Figs. 1-2, Fig. 3 (showing the configuration of the filtering unit 30₂ in the RPU 21); Ex-1003, ¶219.



Ex-1006, Fig. 1.

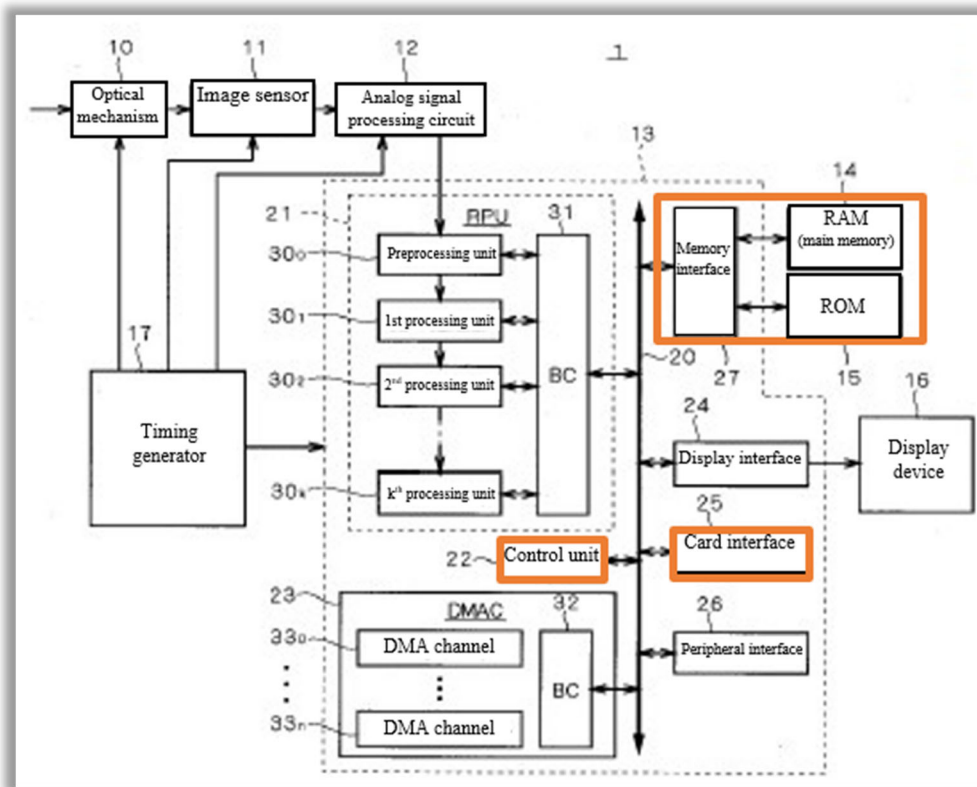
[1A-6]

Matsutani discloses image processing by “control unit 22 [that] has a built-in CPU, and executes a program loaded from the ROM 15 to perform control processing for controlling each processing block in the RPU 21, as well as image processing, etc.” Ex-1010, [0027]. The program loaded from ROM 15 is system software. Ex-1003, ¶220.

[1A-7]

Matsutani teaches correction coefficients stored in main memory 14 for correcting aberrations in image data. Ex-1006, Abstract, [0041], [0045]. Direct

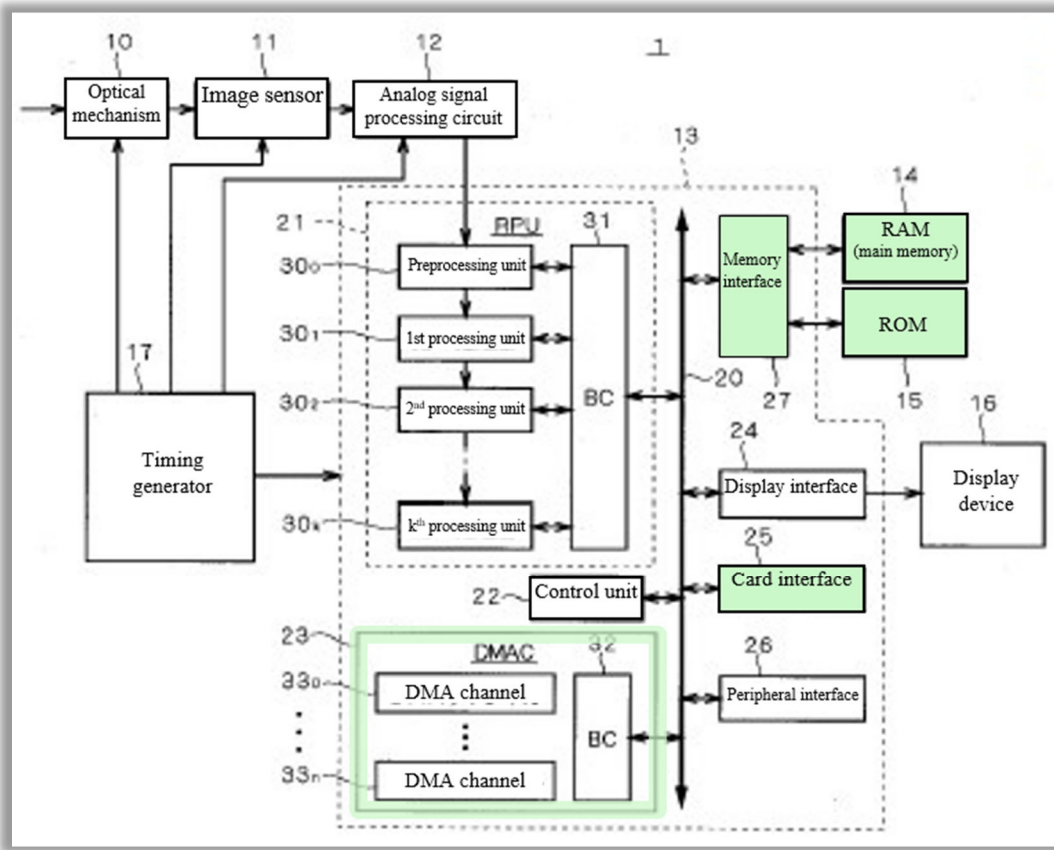
memory access controller (“DMAC”) 23 “reads out, from the main memory 14, coefficient data corresponding to the filter range of 5×5 pixels of input data sampled by the convolution calculator 41, and transfers the coefficient data to the RPU 21 by DMA.” *Id.*, [0045]. Figure 6 shows the coefficient data 42 being transferred to the filtering unit 30₂ by DMA. *Id.*, Fig. 6. Control unit 22 or the DMAC 23 performs data transfers for the coefficient data through a memory interface 27 from the ROM 15 or via a card interface 25 from a portable memory card. *Id.*, [0028]. The RAM 14, ROM 15, control unit 22, card interface 25, and memory interface 27 operate together as a database management system (orange). *Id.*, Fig. 1; Ex-1003, ¶221.



Ex-1006, Fig. 1.

[1A-8]

Matsutani discloses RAM (main memory) 14, ROM 15, memory interface 27, and a portable memory card connected via card interface 25 (green). Ex-1006, Fig. 6. Main memory 14 stores coefficient data and temporarily stores data processed by RPU 21 and data generated during operation of control unit 22. *Id.*, [0027], [0045]. “The card interface 25 is a circuit that, under the control of the control unit 22, executes data input/output to/from a portable memory card (not shown) equipped with a non-volatile memory or the like.” *Id.*, [0032]; Ex-1003, ¶222.



Ex-1006, Fig. 1.

[1B]

Matsutani teaches that, “[s]ince the amount of aberration caused by the optical system varies, depending on imaging conditions such as the focal length and aperture value of the optical system, the amount of correction must selected be in accordance with changes in imaging conditions.” Ex-1006, [0003]; Ex-1003, ¶223.

During prosecution of the ’805 Patent, PO stated that “[s]ince the invention that includes the main allowed claims focuses on the filtration of images and image components, the distinction between fixed focal length lenses and zoom lenses are less relevant than the primary issue of filtration.” Ex-1019, 161. PO explained that “[f]ixed and zoom lenses are merely different animals of the species and share numerous components as disclosed in the original disclosure[.]” *Id.*; Ex-1003, ¶224.

A POSA would have understood Matsutani discloses adjustments for various focal lengths which makes implementation using fixed focal lenses an obvious design choice. Ex-1003, ¶225.

[1C]

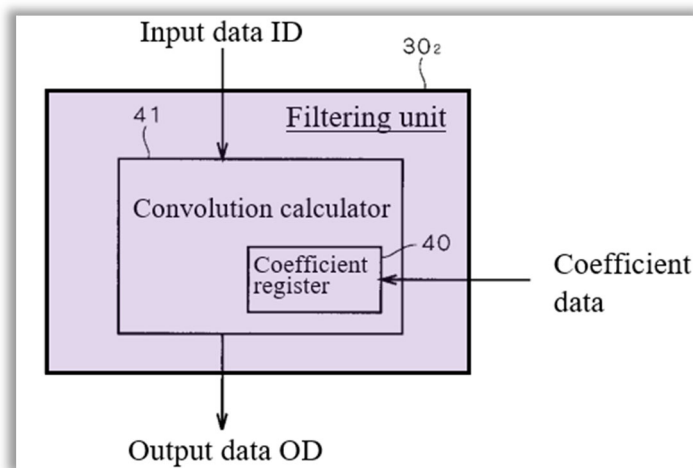
Matsutani identifies a wide range aberrations that should be corrected: “the amount of correction must be selected in accordance with changes in imaging conditions.” Ex-1006, [0003]. The CPU (i.e., the microprocessor) “executes a program loaded from the ROM 15 to perform control processing for controlling each processing block in the RPU 21, as well as image processing, etc.” *Id.*, [0027].

Further, in one embodiment, DMAC 23 selectively reads out, from the main memory 14, (correction) coefficient data corresponding to the filter range of 5×5 pixels of input data sampled by the convolution calculator 41, and transfers that coefficient data to RPU 21. *Id.*, [0045]; Ex-1003, ¶226.

[1D]

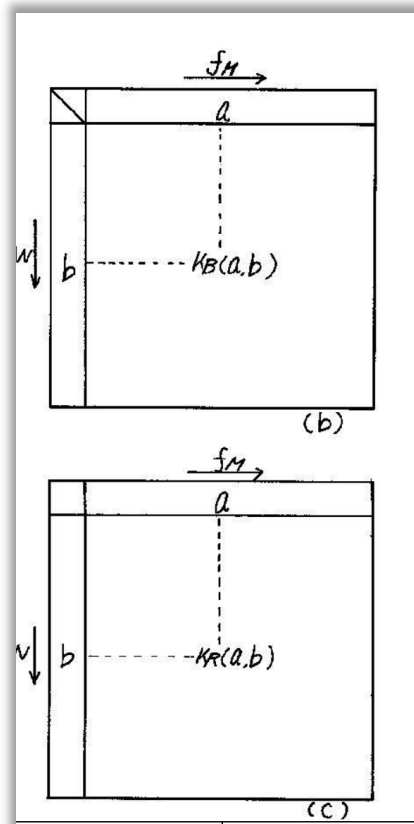
As explained in [1C], Matsutani discloses that the CPU (i.e., the microprocessor) selects the amount of correction and contemplates multiple correction techniques pointing to Shiomi and Ito. Ex-1006, [0003], [0027], [0045], Fig. 6; Ex-1003, ¶227.

Figure 3 depicts how the convolution calculator 41 of the filtering unit 30₂ (purple) receives coefficient (correction) data and input (image) data ID for performing a convolution operation to correct optical aberrations in the input (image) data. Ex-1003, ¶228.



Ex-1006, Fig. 3.

To the extent not expressly disclosed, a POSA would have been motivated to combine the teachings of Shiomi with Matsutani. Ex-1003, ¶229. Shiomi discloses accessing a database (tables) to identify data for its algorithm to correct optical aberrations. Ex-1011, [0021] (“Figure 6(b) and (c) are diagrams illustrating tables in which aberration correction coefficients K_B and K_R corresponding to focal length information f_M and a focusing lens movement amount ΔN are stored, and the manner in which the aberration correction coefficients are determined from the tables [is] in accordance with f_M and ΔN .”), Figs. 6(a)-(b). Ex-1003, ¶229.



Ex-1011, Fig. 6.

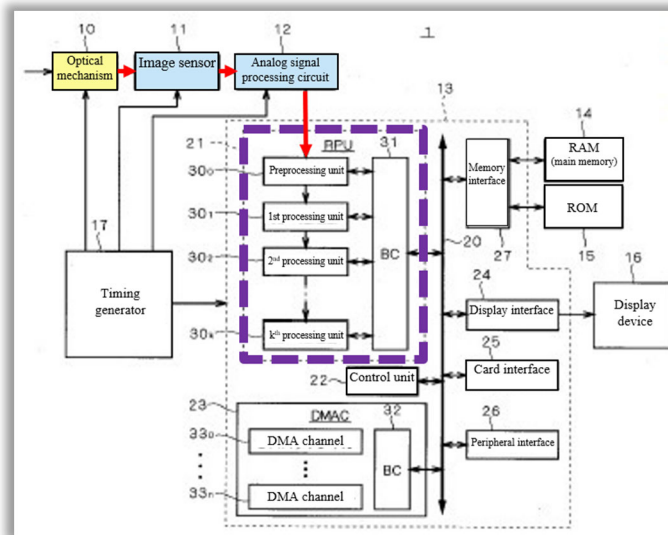
Matsutani and Shiomi establish that “various aberrations (chromatic aberration, spherical aberration, coma aberration, astigmatism, field curvature and distortion, etc.) attributable to the optical system” were known. Ex. 1011, [0003], [0005]. Shiomi and Matsutani both disclose using correction coefficients from a database and Shiomi expressly shows that it was known to include settings for varying focal lengths. Ito adds explicit disclosure using FFT for chromatic aberration. *Id.*; Ex-1003, ¶230.

The motivation to combine Matsutani and Shiomi is especially strong because Matsutani itself explicitly suggests using Shiomi for its aberration correction techniques—thus obvious to try with a reasonable expectation of success. *Outdry Techs. Corp. v. Geox S.p.A.*, 859 F.3d 1364, 1370–71 (Fed. Cir. 2017); Ex-1003, ¶231.

[1E]

Matsutani discloses that image data captured by image sensor 11 is processed and converted to a digital signal by the analog signal processing circuit 12 and then forwarded to RPU 21 (DSP). Ex-1006, [0024], [0026], Fig. 1; Ex-1003, ¶232.

Figure 1 depicts the flow (red) of image data from the optical mechanism 10 (yellow), to the image sensor 11 and the analog signal processing circuit 12 (blue), and to RPU 21 (purple). Ex-1003, ¶233.



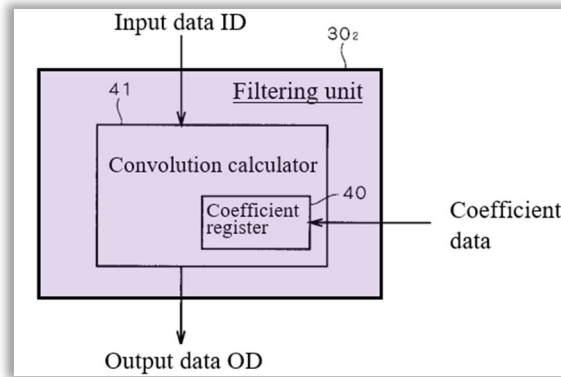
Ex-1006, Fig. 1.

[1F]

Matsutani discloses that the filtration unit 30₂ of RPU 21 (DSP) “enables correction of various aberrations in the image data that are caused by the optical mechanism 10” and is provided with a convolution calculator 41 that samples input (image) pixel data and performs a convolution operation on sampled pixel data using filter coefficients. Ex-1006, [0035], [0041]-[0047]; Ex-1003, ¶234.

“Formula 1” in [0043] discloses an exemplary algorithm for implementing the convolution operation. *Id.*, [0043]; Ex-1003, ¶235.

Figure 3 depicts how the convolution calculator 41 of the filtering unit 30₂ (purple) receives coefficient (correction) data and input (image) data ID for performing a convolution operation to correct optical aberrations in the input (image) data. *Id.*, Fig. 3; Ex-1003, ¶236.



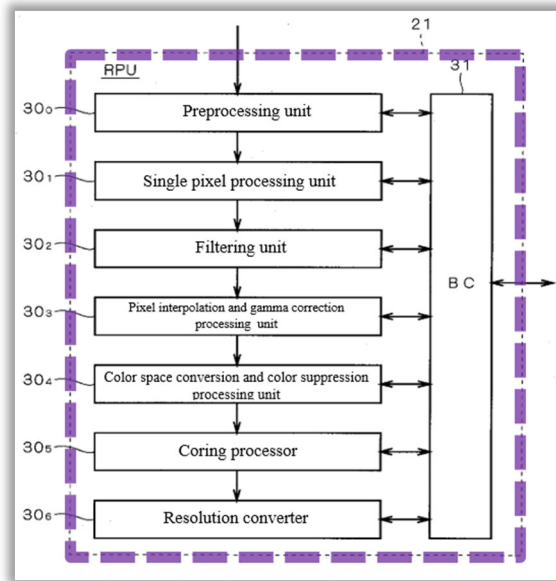
Ex-1006, Fig. 3.

Matsutani also discloses that geometric distortion in the image data, such as barrel aberration, may be corrected by “filtering processing” by dynamically updating the filter coefficients stored in the coefficient register 40 of the filtration unit 30₂. *Id.*, [0048]-[0050], Fig. 7; Ex-1003, ¶237.

Matsutani discloses, wherein the image file (image data) with the at least one optical aberration (e.g., barrel aberration) is corrected by applying digital filtration by using at least one algorithm in the digital signal processor (RPU 21). Ex-1003, ¶238.

[1G]

Matsutani discloses that after correcting the aberration at the filtering unit 30₂, RPU 21 may further process the digital image data in at least processing stages 30₃-30₆. Ex-1006, [0033], [0036]-[0039], Fig. 2. Figure 2 illustrates a configuration of processing stages 30₃-30₆ in RPU 21 (purple). *Id.*; Ex-1003, ¶¶239-40.



Ex-1006, Fig. 2.

Matsutani further discloses that digital image data, corrected and processed in RPU 21, is transferred from RPU 21 and stored in main memory 14. Ex-1006, [0030]. The corrected and processed digital image data may also be stored in a portable memory card via the card interface 25. *Id.*, [0032]; Ex-1003, ¶241.

Accordingly, claim 1 would have been obvious over Matsutani in view of Shiomi. Ex-1003, ¶242.

2. Claim 2

Matsutani discloses a digital imaging system for correcting various optical aberrations, including chromatic aberrations and barrel aberration. Ex-1006, [0003] (“...image data captured by an image sensor includes various aberrations (chromatic aberration, spherical aberration, coma aberration, astigmatism, field curvature and

distortion, etc.) attributable to the optical system...”), [0048]-[0050] (describing an embodiment for correcting barrel aberration); Ex-1003, ¶243.

Accordingly, claim 2 would have been obvious over Matsutani in view of Shiomi. *Id.*, ¶244.

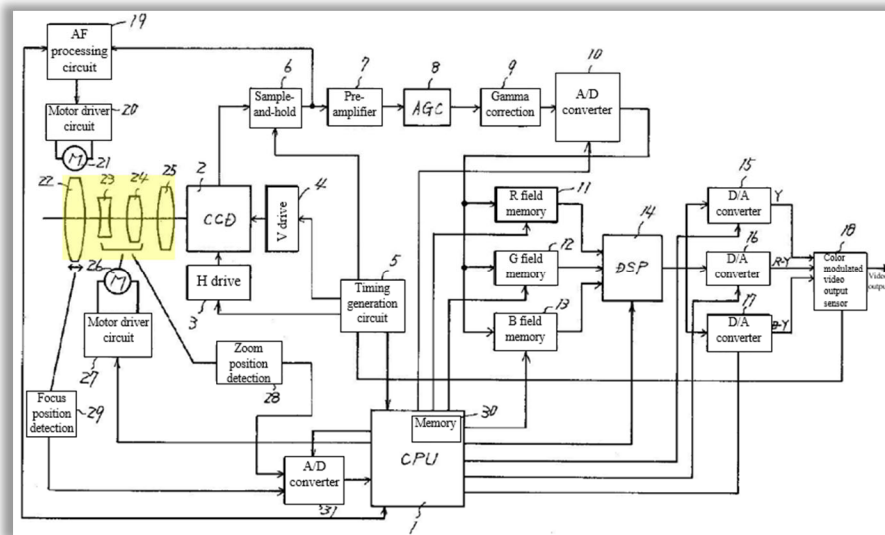
3. Independent Claim 14

[14pre]-[14A-8]

See [1pre]-[1A-8]. Ex-1003, ¶245.

[14B]

Matsutani discloses optical mechanism 10 equipped with an optical lens, but does not explicitly disclose whether the lens is a zoom lens. However, Matsutani explicitly teaches that it is capable of correcting various focal length “[s]ince the amount of aberration caused by the optical system varies, depending on imaging conditions such as the focal length” Ex-1006, [0003]. Shiomi discloses a “four-group type zoom lens [(yellow)] consisting of a focusing lens 22, a variator lens 23, a compensator lens 24, and a relay lens 25.” Ex-1011, [0010], Fig. 1. As such, a POSA would have been motivated to incorporate the zoom lens of Shiomi, referenced by Matsutani. Ex-1003, ¶246.



Ex-1011, Fig. 1.

[14C]

Shiomi discloses that in a video camera with a zoom lens, chromatic aberration of the photographic lens changes depending on the focal length and AF. Ex-1011, [0046]; Ex-1003, ¶247.

Shiomi also discloses a video lens drive unit that a photographer operates to perform zooming and that “in conjunction with the movement of the lenses, the current focal length information of the photographic lens is detected by a zoom position detection circuit 28.” Ex-1011, [0048]; Ex-1003, ¶¶248-49.

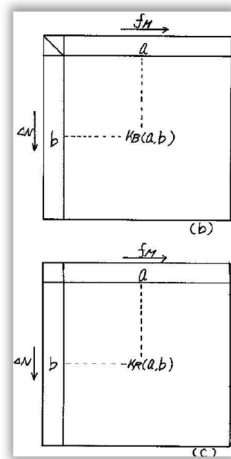
[14D]

See [1E], [1G]. Ex-1003, ¶250.

[14E]

Matsutani discloses this limitation as explained in [1C]. Ex-1003, ¶251.

To the extent not expressly disclosed, a POSA would have motivated to combine the teachings of Shiomi with Matsutani. Shiomi discloses that correction data corresponding to the different focal lengths is stored in a database. Ex-1011, [0021] (“...Figure 6(b) and (c) are diagrams illustrating tables in which aberration correction coefficients K_B and K_R corresponding to focal length information f_M and a focusing lens movement amount ΔN are stored...”), Figs. 6(b) and 6(c) (below, showing the arrangement of aberration correction coefficients in a database); Ex-1003, ¶¶252-53.



Ex-1011, Fig. 6.

Matsutani discloses and Matsutani in view of Shiomi render obvious wherein the microprocessor (CPU) uses system software (program run by the CPU) to access the database (correction data or a database storing aberration correction coefficients K_B and K_R corresponding to focal length information f_M and a focusing lens movement amount ΔN) to identify at least one optical aberration in the image file at

any focal length of a zoom lens configuration. Ex-1003, ¶254.

[14F]

Matsutani renders obvious this limitation as explained in [1D] and [1F]. Specifically, Matsutani discloses various correction techniques and amounts of correction can be used. Ex-1006, [0003]. Shiomi also discloses the required limitations. A POSA would have understood that the teachings of Shiomi could be combined with Matsutani to satisfy the requirements of claim [14F]. Ex-1003, ¶256. Shiomi discloses that the microprocessor accesses tables (a database) to obtain aberration correction coefficients. Ex-1011, [0021]. A POSA would have understood that that the aberration correction coefficients of Shiomi could be applied to the filtration correction algorithm (“Formula 1”) of Matsutani. Ex-1003, ¶257. A POSA would understand the coefficients and related algorithms are or can be stored and accessed to perform the correction. *Id.*, ¶¶255-57.

Matsutani in view of Shiomi render obvious wherein the microprocessor (CPU) accesses the database to obtain at least one filtration correction algorithm (convolution algorithm shown as “Formula 1”) to the optical aberrations and forwards the at least one filtration algorithms to the digital signal processor (RPU 21). *Id.*, ¶258.

[14G]

Matsutani discloses that the image file is forwarded to RPU 21 (DSP) which

applies the convolution algorithm “Formula 1” to correct the aberrations, as explained in [1E] and [1F]. Ex-1003, ¶259.

Shiomi discloses that the aberration correction coefficients are selected according to the specific focal length in the zoom lens configuration. Ex-1011, [0021], Figs. 6(b), 6(c). Because a POSA would know that aberrations are focal length specific, Shiomi makes explicit that the aberration correction would include focal length in the algorithm. *Id.*, ¶260.

Matsutani in view of Shiomi render obvious wherein the image file is forwarded to the digital signal processor (RPU 21) which applies at least one filtration algorithm (e.g. the convolution algorithm “Formula 1”) to optimize the image and corrects the at least one optical aberration at the specific focal length in the zoom lens configuration. *Id.*, ¶261.

[14H]

See [1A-8], [1G], [14G]. Ex-1003, ¶262.

Accordingly, claim 14 would have been obvious over Matsutani in view of Shiomi. *Id.*, ¶263.

4. Claim 15

See [2]. Ex-1003, ¶264.

Accordingly, claim 15 would have been obvious over Matsutani in view of Shiomi. *Id.*, ¶265.

5. Claim 17

Matsutani in view of Shiomi disclose this limitation as explained in [1C]. Specifically, the CPU analyzes the focal length at the time of imaging for the zoom lens and uses that focal length information f_M and a focusing lens movement amount ΔN to select specific correction (coefficient) data from the main memory 14. Each focal length corresponds with a different set of aberrations. Ex-1003, ¶266.

Matsutani in view of Shiomi discloses wherein each focal length of a zoom lens is analyzed for a different set of optical aberrations. *Id.*, ¶267.

Accordingly, claim 17 would have been obvious over Matsutani in view of Shiomi. *Id.*, ¶268.

D. Ground 4.

1. Claim 3

[3A]

Matsutani discloses that image data captured by an image sensor includes various aberrations and that the single pixel processing unit 30₁ of RPU 21 (DSP) performs “shading correction processing to correct uneven brightness in the image.” Ex-1006, [0003], [0034]; Ex-1003, ¶270.

Image data captured with a lens will include vignetting and that “shading correction processing to correct uneven brightness in the image” includes processing to correct vignetting. *Id.*, ¶271.

[3B]

This claim element is written in the alternative, requiring only one of the potential sub-elements to be applied by the digital signal processor. Ex-1003, ¶272.

Matsutani discloses that RPU 21 (DSP) “performs shading correction processing to correct uneven brightness in the image” (Ex-1006, [0034]), but does not explicitly teach an algorithm to lighten the corners of the image. Ex-1003, ¶273.

Enomoto II teaches an algorithm that can be used to correct for a decrease in marginal lumination of an image. Ex-1013, 4:21-40. A POSA would have understood that a decrease in marginal lumination relates to the problem of vignetting, and can be corrected by lightening the corners of an image. Ex-1003, ¶274. Specifically, Enomoto II discloses that lens characteristics “such as the decrease in the marginal lumination...can be approximated to some extent by a cubic function which uses a distance (which is expressed by, e.g., x-y) from the optical axis of the lens, i.e., from the center of the image as a parameter.” Ex-1013, 4:24-29. This function can be stored as lens characteristics that the characteristic correction unit 36 uses to correct aberrations include the decrease in marginal lumination. *Id.*, 3:33-49; 4:29-40; Fig. 2. This function (algorithm) to correct aberrations including a decrease in marginal lumination would have been implemented with RPU 21 (DSP). Ex-1003, ¶274.

Matsutani instructs a POSA to consider other image correction techniques. A POSA would have been motivated to correct a decrease in marginal lumination (vignetting) using the method taught by Enomoto II because it would have been an application of a known technique for the in-camera software correction of vignetting to improve similar devices (the digital camera 1 of Matsutani), in the same way (by having RPU 21 perform the computation to correct the decrease in marginal lumination). Ex-1003, ¶275.

A POSA would have had a reasonable expectation of success of implementing the peripheral shading correction technique taught by Enomoto II in the camera 1 of Matsutani because the technique could be implemented in RPU 21 in the same way as other optical aberrations are corrected. *Id.*, ¶276.

[3C]

A POSA would have understood that the Enomoto II function (algorithm) would correct a decrease in marginal lumination (vignetting) implemented on RPU 21 (DSP) based on image exposure. Ex-1003, ¶¶277-78.

Accordingly, claim 3 would have been obvious over Matsutani in view of Shiomi and Enomoto II. *Id.*, ¶279.

2. Claim 5

[5A]

Enomoto II discloses the need for storing lens characteristics for multiple lens types when using interchangeable lenses in the camera: “In the case of taking a photo using such an interchangeable lens, there are required the lens characteristics of the interchangeable lens. Therefore, the lens characteristics corresponding to lens data are stored for every usable interchangeable lens, the interchangeable lens data are received from the interchangeable lens on the occasion of the photography, and the aberrations described above may be corrected based on the lens characteristics.” Ex-1013, 6:45-52; Ex-1003, ¶280.

A POSA would have been motivated to register each lens type as a selection condition in the database to improve the versatility of the camera and accommodate the design choice of accommodating multiple interchangeable lenses (optical mechanism 10). *Id.*, ¶281.

A POSA would have had a reasonable expectation of success of registering each lens type in the camera database because the lens type could be loaded into the main memory 14 in the same way that the correction data is loaded said memory, i.e., by transfer from the ROM 15 or a memory card via the card interface 25. *Id.*, ¶282.

[5B]

Enomoto II discloses that the characteristic correction unit 36 memorizes the lens characteristics of the image forming lens 32 and corrects multiple optical aberrations of the image on the basis of the lens characteristics. Ex-1013, 4:16-20; Ex-1003, ¶283.

Enomoto II also discloses that when using a zoom lens “the aberrations described above may be corrected preferably based on the lens characteristics corresponding to each focal length...it is preferable to store the lens characteristics at a plurality of focal lengths of the zoom lens, convert the lens characteristics at the plurality of focal lengths with the focal length when photographed, and obtain the lens characteristic at the focal length when photographed through the lens. Herein, as for the lens characteristics, each of the lens characteristics at switchable focal lengths may be held (stored), or the lens characteristic at each focal length exhibiting a high photographic probability, may respectively be stored, or the lens characteristics on the order of three stages such as T (Telephoto), M (Middle, or Standard) and W (Wide-angle) may be stored.”). *Id.*, 6:22-36; Ex-1003, ¶284.

[5C]

Matsutani discloses this limitation as explained in [1D] and [5B]. Specifically, Matsutani discloses filtration solutions stored in the main memory 14. The correction data is transferred to the RPU 21 and used in the exemplary

convolution algorithm “Formula 1” to correct aberrations in the image data.
Ex-1006, [0035], [0041], [0043]; Ex-1003, ¶¶285-86.

[5D]

Matsutani discloses this limitation as explained in [1F]. To the extent not expressly disclosed, Matsutani in view of Enomoto III render this limitation obvious as explained in [5C]. Ex-1003, ¶287.

[5E]

See [1G]. Ex-1003, ¶288.

Accordingly, Matsutani in view of Shiomi and Enomoto II render obvious claim 5. *Id.*, ¶289.

3. Claim 18

[18A]-[18C]

See [3A]-[3C]. Ex-1003, ¶290.

Accordingly, Matsutani in view of Shiomi and Enomoto II render obvious claim 18. *Id.*, ¶291.

E. Ground 5

1. Claim 4

Matsutani does not explicitly disclose using a fast Fourier transform (FFT) algorithm to correct an aberration, but FFT was well known as conceded during prosecution, see *supra* Section V.B.1. Ito discloses that a FFT algorithm can be used

to correct chromatic aberration by “digital signal processing.” Ex-1009, [0017]-[0018]; Ex-1003, ¶293.

At least because Matsutani references Ito’s disclosure of techniques for correcting aberrations, including chromatic aberration, Ex-1006, [0003], a POSA would have been motivated to try and implement a FFT algorithm in the RPU 21 (DSP) to correct chromatic aberration. For the above-stated reason, a reasonable expectation of success also existed. Ex-1003, ¶294.

Accordingly, Matsutani in view of Shiomi and Ito render obvious claim 4. *Id.*, ¶295.

2. Claim 16

See [4]. Ex-1003, ¶296.

Accordingly, claim 16 would have been obvious over Matsutani in view of Shiomi and Ito. *Id.*, ¶297.

F. Secondary Considerations of Non-Obviousness

Petitioners are unaware of any applicable secondary considerations of non-obviousness. None were identified or asserted during prosecution. *See generally* Ex-1002. Regardless, even if such considerations existed, none would overcome the strong *prima facie* showing of obviousness. Ex-1003, ¶298.

VI. Discretionary Denial is Unwarranted

A. *General Plastic* Favors Institution

Each *General Plastic* factor favors institution or is neutral. The '339 Patent has been subject to two IPR Petitions: *Canon Inc., v. Optimum Imaging Technology, LLC*, No. IPR2020-01322 (“Canon IPR”), denied on discretionary grounds, and *Sony Corp., v. Optimum Imaging Technology, LLC*, No. IPR2024-00925 (“Sony IPR”), pending.

Factor One favors institution because Petitioners have had no involvement with the Sony IPR or Canon IPR, and Petitioners lack any legally significant relationship with Sony and Canon. *Ericsson Inc., v. General Access Solns., Ltd.*, IPR2024-00392, Paper 13 at 25; *see also LG Elecs., Inc. v. Bell N. Research, LLC*, IPR2020-00319, Paper 15 at 15 (“[A]n unrelated Petitioner presenting some new references... weighs against denying institution under §314(a) quite heavily.”). Thus, “factor one necessarily outweighs the other *General Plastic* factors.” *Videndum Production v. Rotolight*, IPR2023-01218, Paper 12 at 6 (PTAB Apr. 19, 2024) (Director Review).

Factor Two favors institution. These grounds rely on references different from those raised in the Sony IPR and that were not substantively considered during prosecution. Although Niikawa was relied on in the Canon IPR, Petitioners were not a party to that IPR and the remaining references in this Petition were not.

Petition for *Inter Partes* Review of
U.S. Patent No. 8,451,339

Moreover, the Canon IPR was denied on discretionary grounds; the Office did not consider Niikawa or the substantive arguments.

Factor Three favors institution as well. In the Sony IPR, PO has yet to file a preliminary response and the Board has not yet issued a decision regarding institution. Moreover, Petitioners were not parties to the Canon IPR and the grounds asserted were different than the ones here. The Canon IPR was denied on discretionary grounds and the Office did not consider Niikawa or the substantive arguments. In addition, PO did not assert the '339 Patent against Petitioners (or related entities) until years after suing Canon. Accordingly, road-mapping gamesmanship concerns like those at issue in *General Plastic* are inapplicable.

Factors Four and Five favor institution. Petitioners have had no involvement with the Sony IPR or Canon IPR, so—unlike in *General Plastic*—it does not make sense to hold Petitioners responsible for the time elapsed since filing of an unrelated petition. Regardless, Petitioners pursued their unpatentability grounds, which are different in content and scope from those in the Sony IPR and Canon IPR, with reasonable diligence.

Factor Six favors institution because this Petition raises grounds not raised in the Sony IPR or Canon IPR. Accordingly, IPR of the grounds raised here makes good use of the Board's limited resources for "improving patent quality by reviewing

the merits of the [raised] challenges.” *Code200, UAB v. Bright Data, Ltd.*, IPR2022-00861, Paper 18 at 6.

Factor Seven favors institution because nothing in this Petition will impede the Board from issuing a final written determination within one year of IPR institution.

B. *Sotera* Stipulations Moot *Fintiv*

Each Petitioner has provided a *Sotera* stipulation (Ex-1024), so “the PTAB will not discretionarily deny institution in view of parallel district court litigation where petitioner presents [such] a stipulation....” See Memorandum on “Interim Procedure for Discretionary Denials.”

C. 35 U.S.C. § 325(d)

Discretionary denial is unwarranted because the Office never considered the patentability of Challenged Claims over any of the grounds here, or art substantially similar thereto, failing *Advanced Bionics* step one. Moreover, the Canon IPR was denied on discretionary grounds and the Office did not consider Niikawa or the substantive arguments.

VII. Payment of Fees

The U.S. Patent and Trademark Office is hereby authorized to charge any fees due during the IPR proceeding to Deposit Account No. 50-3013 (Order No. 104790-000004).

VIII. Mandatory Notices

A. Real Party-in-Interest

Petitioners certify that they are the only real parties-in-interest.

B. Related Matters

As mentioned above, the Canon IPR and Sony IPR involved the '339 Patent.

The following district court actions involve the '339 Patent.

1. U.S. District Court for the Eastern District of Texas.

(i) *Optimum Imaging Technologies LLC v. FUJIFILM Corporation*, Case No. 4-23-cv-00922; (ii) *Optimum Imaging Technologies LLC v. Nikon Corporation*, Case No. 4-23-cv-00923; (iii) *Optimum Imaging Technologies LLC v. Olympus Corporation, et al.*, Case No. 4-23-cv-00924; (iv) *Optimum Imaging Technologies LLC v. Panasonic Corporation*, Case No. 4-23-cv-00926; (v) *Optimum Imaging Technologies LLC v. Sony Corporation*, Case No. 4-23-cv-00928; (vi) *Optimum Imaging Technologies LLC v. Samsung Electronics Co., Ltd.*, Case No. 4:23-cv-00927.

2. U.S. District Court for the Western District of Texas

Canon Inc. v. Optimum Imaging Technologies LLC, Case No. 1:20-cv-01238
(Terminated April 28, 2021).

3. U.S. District Court for the Northern District of California

(i) *Panasonic Entertainment & Communication Co., Ltd. v. Optimum Imaging Technologies LLC*, Case No. 3:24-cv-02466; (ii) *FUJIFILM North America Corporation v. Optimum Imaging Technologies LLC*, Case No. 4:24-cv-03297.

Out of an abundance of caution, Petitioners also note that the '339 Patent is in the same family as three other patents: (i) the '805 Patent; (ii) U.S. Patent No. 10,873,685; and (iii) U.S. Patent No. 10,877,266. Petitioners are currently challenging the '805 and '685 Patents, respectively, in: (i) IPR2024-01373, and (ii) IPR2024-01220. Sony has challenged these three patents, respectively, in: (i) IPR2024-00924; (ii) IPR2024-00923; and (iii) IPR2024-01046.

C. Notice of Counsel and Service Information

Petitioner Nikon Corporation designates Matthew W. Johnson (Reg. No. 59,108) as lead counsel for this Petition, with Keith B. Davis (*pro hac vice* to be filed), Marc S. Blackman (Reg. No. 43,501), and John R. O'Donnell (Reg. No. 76,940) as back-up counsel.

Petitioners Olympus Corporation and OM Digital Solutions Corporation designate Alexander B. Stein (Reg. No. 71,397), Manita Rawat (Reg. No. 61,944), Daniel J. Tarr (Reg. No. 66,595), and Peter M. Loderup (Reg. No. 79,839) as back-up counsel.

Petition for *Inter Partes* Review of
U.S. Patent No. 8,451,339

Petitioners FUJIFILM Corporation and FUJIFILM North America Corporation designate T. Vann Pearce, Jr. (Reg. No. 58,945) and Anri Nakamoto (pro hac vice to be filed) as back-up counsel

Petitioner Panasonic designates Joseph M. Casino (Reg. No. 57,224) and Thomas M. Landman (Reg. No. 71,073) as back-up counsel.

Petitioners request service via electronic mail at OIT-685Patent-IPR@morganlewis.com, mwjohnson@jonesday.com, kbdavis@jonesday.com, msblackman@jonesday.com, jodonnell@jonesday.com, anakamoto@orrick.com, TVPPTABDocket@orrick.com, jcasino@wiggin.com, and tlandman@wiggin.com.

Pursuant to 37 C.F.R. §42.10(b), each of the Petitioners is filing their respective Power of Attorney concurrently herewith.

IX. Conclusion

As explained above, Petitioners are likely to prevail in showing that at least one of the Challenged Claims is unpatentable and request that IPR be instituted and that the Challenged Claims be canceled.

Petition for *Inter Partes* Review of
U.S. Patent No. 8,451,339

Respectfully submitted,

Dated: August 30, 2024

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Petition for *Inter Partes* Review of
U.S. Patent No. 8,451,339

CERTIFICATE OF WORD COUNT

The undersigned certifies that the foregoing PETITION FOR *INTER PARTES* REVIEW complies with the type volume limitation in 37 C.F.R. § 42.24(a)(1)(i). According to the utilized word-processing system's word count, the petition—excluding the caption, table of contents, table of exhibits, mandatory notices, certificate of word count, and certificate of service—contains 13,622 words.

Dated: August 30, 2024

/Matthew W. Johnson/

Attorney for Petitioners

CERTIFICATE OF SERVICE

The undersigned hereby confirms that the foregoing PETITION FOR IPR and associated exhibits were caused to be served on August 31, 2024 via overnight courier upon the following counsel of record for Patent Owner:

Michael J. Scheer
The Law Office of Michael J. Scheer
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Courtesy copies were also served on August 30, 2024, via electronic mail on Patent Owner's counsel of record in a related district court litigation:

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