

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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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.

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Case IPR2024-01372

Patent No. 8,451,339

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**DECLARATION OF ROBERT L. STEVENSON**

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## **I. Introduction**

1. My name is Robert L. Stevenson. I have been retained by counsel for Olympus Corporation, OM Digital Solutions Corporation, FUJIFILM Corporation, FUJIFILM North America Corporation, Nikon Corporation, and Panasonic Entertainment & Communication Co., Ltd. (“Petitioners”) as an expert witness in this *inter partes* review to examine whether claims 1-5 and 14-18 of U.S. Patent No. 8,451,339 (“the ’339 Patent” or “Ex-1001”) are patentable over certain prior art. I understand the ’339 Patent is currently assigned to Optimum Imaging Technologies LLC (“Patent Owner”).

2. I have personal knowledge of all the facts set forth herein, and if called to testify at any hearing in this *inter partes* review, I would competently testify and verify that testimony contained herein.

3. I am being compensated at my hourly rate of \$750 per hour. I am also being reimbursed for out-of-pocket expenses. My compensation does not depend in any way on the outcome of this proceeding or the particular opinions I express, or the testimony I give.

4. I expect to be available for deposition and to testify at the evidentiary hearing in this *inter partes* review to the extent required.

5. This declaration contains my conclusions and a summary of my analysis including a summary of my conclusions; an overview of my qualifications

as an expert; an overview of the scope and terms of my engagement for this declaration; an overview of the materials I have considered in arriving at my conclusions; an overview of the terminology and legal principles that I applied in my analysis; an overview of the technical background of the subject matter; an overview of the '339 Patent; an analysis of the level of ordinary skill in the art related to the '339 Patent; and an analysis of the asserted references; and a patentability analysis of the challenged claims.

6. This declaration is based on information currently available to me. I intend to continue my investigation and study, which may include a review of documents and information that may yet be produced, as well as deposition testimony from depositions for which transcripts are not yet available or that may yet be taken in this review. Therefore, I expressly reserve the right to expand or modify my opinions as my investigation and study continue, and to supplement my opinions in response to any additional information that becomes available to me, any matters raised by Patent Owner and/or other opinions provided by Patent Owner's expert(s), or in light of any relevant orders from the Patent Trial and Appeal Board or other authoritative body.

## **II. Background and Qualifications**

7. My qualifications and professional experience are described in my Curriculum Vitae, a copy of which can be found in Ex-1004. The following is a brief summary of my relevant qualifications and professional experience.

8. I have a bachelor's degree in Electrical Engineering from the University of Delaware and a Ph.D. degree in Electrical Engineering from Purdue University. My Ph.D. research was on communications and signal processing.

9. I am presently a Professor in the Department of Electrical Engineering and in the Department of Computer Science and Engineering at the University of Notre Dame. I first joined the faculty at the University of Notre Dame as an Assistant Professor in the Department of Electrical Engineering in 1990. I was granted tenure and promoted to the rank of Associate Professor in August 1996. I attained the rank of Professor in the Department of Electrical Engineering in August 2002, and I continue to serve in that capacity. I have served concurrently as a Professor in the Department of Computer Science and Engineering at the University of Notre Dame from January 2003 through June 2018.

10. Since 2013 I have served as an Associate Chair of the Department of Electrical Engineering. I also serve as the Director of Undergraduate Studies in Electrical Engineering. In this role I oversee the department's undergraduate program in Electrical Engineering.

11. I spent the summer of 1992 at the Air Force Research Lab in Rome, New York and I spent the summer of 1993 at the Intel® Corporation in Hillsboro, Oregon. Several leading computing companies, including Intel®, Sun Microsystems®, Apple® Computer, and Microsoft®, have supported my research at Notre Dame. During the past 20 years, I have published over 150 technical papers related to the field of image processing and digital systems.

12. I am a member of the Institute of Electronics and Electrical Engineers, The International Society for Optical Engineering, and the Society for Imaging Science and Technology. I am a member of the academic honor societies Eta Kappa Nu, Tau Beta Pi, and Phi Kappa Phi.

13. For the past 20 years my work has focused on the design of techniques, hardware, and software for the processing of digital signals using digital computing devices. As an academic researcher I attempt to develop novel ideas for systems, then publish and present those ideas to the technical community. My success as an academic is directly related to the insights and techniques that provide the basis for new generations of products. My early work on digital techniques for printing and image capture devices led to significant interaction with companies developing desktop computers products in the early 1990's as they tried to incorporate those ideas into their products.

14. My interaction with Apple's Imaging Group focused on various imaging devices such as digital cameras, scanners, and printers and how to best support those devices on desktop computers. At Intel, I worked in Intel's Architecture Lab at the time the MMX multimedia instructions were being incorporated into the Pentium processor. My work there dealt with developing video compression techniques for CD-ROM's and network communications that were well matched to the Pentium architecture. I also gave a series of talks on how advanced communication and video processing techniques could be better supported on the Pentium platform. Similarly, my interaction with Sun Microsystem's group examined how advanced signal processing techniques could be best implemented using Sun's new Visual Instruction Set on the Sparc architecture.

15. I have also received significant support for my research from several U.S. Department of Defense Agencies. The Air Force Research Laboratory has funded my work to develop advanced parallel processing algorithms that exploited an ad-hoc network of mixed computers to achieve significant computational advantages over their previously implemented techniques. Other Department of Defense agencies have supported my work in image and video enhancement.

16. Through my work I have contributed significantly to the understanding and modeling of the limitations of and aberrations found in optical image capture systems. For example, I directed a Ph.D. dissertation entitled "Modeling,

Approximation, and Estimation of Spatially-varying Blur in Photographic Systems” with my student John Simpkins and co-authored several papers in the 2011-2016 directly on the modeling of optical systems.

17. Additionally, I have developed numerous novel computational algorithms to overcome such issues with optical capture systems over the past 30 years. Some examples include “Improved Definition Image Expansion” (1994), “Color Palette Restoration” (1995), “Extraction of High-Resolution Frames from Video Sequences” (1996), “Reduced-Complexity Iterative Post-Filtering of Video” (2001), “Improving the Performance of Single Chip Image Capture Devices” (2003), “Estimation Theoretic Approach to Dynamic Range Improvement Through Multiple Exposures” (2003), “A Parameterized Spatially-Varying PSF Model” (2014), “Multi-Image Motion Deblurring Aided By Inertial Sensors” (2016), “Inertial Sensor Aided Multi-Image Nonuniform Motion Blur Removal Based on Motion Decomposition” (2018), “Deep Motion Blur Removal Using Noisy/Blurry Image Pairs” (2021), and “DeblurExpandNet: Image Motion Deblurring Network Aided by Inertial Sensor Data” (2022). These references were all published in peer referred international journals and have collectively been cited thousands of times in the field. I have also presented such work at international conferences around the world. Complete citations to this work can be found in my curriculum vitae which is included as Ex-1004.

18. I have published over 150 papers in international journals and international conferences.

19. I am an inventor of U.S. Pat. No. 6,081,552, “Video Coding Using a Maximum A Posteriori Loop Filter,” June 27, 2000.

20. Additional information concerning my background, qualifications, publications, conferences, honors, and awards are described in my Curriculum Vitae (Ex-1004).

### **III. Materials Reviewed**

21. In reaching the conclusions described in this declaration, I have relied on the documents and materials recited herein as well as those identified in this declaration, including the '339 Patent, the prosecution history of the '339 Patent, the prior art references, and information discussed and any other references specifically identified in this declaration, including the materials identified in the chart below.

| <b>Exhibit</b> | <b>Description</b>                                                             |
|----------------|--------------------------------------------------------------------------------|
| Ex-1001        | U.S. Pat. No. 8,451,339 (“’339 Patent”)                                        |
| Ex-1002        | Prosecution History of the ’339 Patent Sans NPL                                |
| Ex-1003        | [Reserved]                                                                     |
| 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”)                               |

| <b>Exhibit</b> | <b>Description</b>                                                                                                                                                                                                                                                                                                       |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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), <a href="https://web.archive.org/web/20060420051054/http://www.ricoh.co.jp/about/business_overview/report/31/">https://web.archive.org/web/20060420051054/http://www.ricoh.co.jp/about/business_overview/report/31/</a> (“Ricoh”) |
| Ex-1026        | <i>Ricoh Technical Report No. 31</i> , RICOH (Apr. 20, 2006), <a href="https://web.archive.org/web/20060420051054/http://www.ricoh.co.jp/about/business_overview/report/31/">https://web.archive.org/web/20060420051054/http://www.ricoh.co.jp/about/business_overview/report/31/</a> (“Ricoh-JP”)                       |

#### **IV. Summary of Opinions**

22. Ground 1(a): It is my opinion that claims 1, 3, and 5 are obvious over Niikawa.

23. Ground 1(b): It is my opinion that claims 1-3, 5, 14-15, and 17-18 are obvious over Niikawa in view of Enomoto.

24. Ground 2(a): It is my opinion that claim 4 is obvious over Niikawa in view of Ito.

25. Ground 2(b): It is my opinion that claims 4 and 16 are obvious over Niikawa in view of Enomoto and Ito.

26. Ground 3: It is my opinion that claims 1-2, 14-15 and 17 are obvious over Matsutani in view of Shiomi.

27. Ground 4: It is my opinion that claims 3, 5 and 18 are obvious over Matsutani in view of Shiomi and Enomoto II.

28. Ground 5: It is my opinion that claims 4 and 16 are obvious over Matsutani in view of Shiomi and Ito.

## **V. Understanding of the Law**

29. I am not a legal expert. In forming my opinions, I have been informed of and applied the legal standards as follows. I understand that the legal standards relating to anticipation and obviousness apply to the '339 Patent and have been instructed to assume an effective filing date of July 11, 2006.

30. I understand that a patent claim is invalid if the claimed invention is not new. For a claim to be invalid on the basis of anticipation because it is not new, all of its elements must be present, either expressly or inherently, in a single previous device or method, or described, either expressly or inherently, in a single previous publication or patent.

31. I understand that the description in a reference does not have to be in the same words as the claim, but all the requirements of the claim must be there, either stated expressly or necessarily implied or inherent to one of ordinary skill in the field of technology of the patent at the time of the invention, so that someone of ordinary skill in the field of technology of the patent looking at that one reference would be able to make and use the claimed invention. I further understand that to be necessarily implied or inherent, the claim element must be a necessary part of the reference that is not expressly disclosed. Merely being one option is not sufficient for a claim element to be necessarily implied or inherent to a person of ordinary skill in the art (“POSA”).

32. I have been informed that in relying upon the theory of inherency, there must be a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art.

33. I understand that a patent claim is “obvious” and therefore invalid when the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a POSA to which the subject matter pertains.

34. In making an obviousness determination, I understand that there are several factors to consider: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art at the time of the effective filing date of the claimed invention; (3) the differences between the claimed invention and the prior art, if any, and (4) objective considerations, if any exist, such as any commercial success, copying, prior failure by others, licenses, longstanding need, and unexpected results.

35. I understand that prior art used to show that a claimed invention is obvious must be “analogous art.” Prior art is analogous art to the claimed invention if (1) it is from the same field of endeavor as the claimed invention (even if it addresses a different problem) or (2) the reference is reasonably pertinent to the problem faced by the inventor (even if it is not from the same field of endeavor as the claimed invention).

36. I have been informed and understand that the U.S. Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include the following: (a) combining prior art elements according to known methods to yield predictable results; (b) simple substitution of one known element for another to obtain predictable results; (c) use of a known technique to improve a similar device (method, or product) in the same way; (d) applying a known technique to a known

device (method, or product) ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and (f) some teaching, suggestion, or motivation in the prior art that would have led a POSA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

37. Also, I have been informed and understand that obviousness does not require physical combination/bodily incorporation, but rather consideration of what the combined teachings would have suggested to a POSA at the time the claimed invention was made.

38. I understand that it is improper to engage in hindsight when trying to determine the obviousness of a patent claim. I understand that the obviousness inquiry must be conducted from the standpoint of a POSA at the time the claimed invention was made. What is known today, and what is learned from the teachings and disclosures of the patent itself containing the claim under analysis, should not be considered.

39. I have been informed that various “secondary considerations” (sometimes referred to as objective indicia of non-obviousness) may support a determination of non-obviousness and that such secondary considerations must be

considered as part of an obviousness analysis. I have been informed that secondary considerations of non-obviousness may include:

- a. commercial success of a product due to the merits of the claimed invention;
- b. a long felt need for the solution provided by the claimed invention;
- c. unsuccessful attempts by others to find the solution provided by the claimed invention;
- d. copying of the claimed invention by others;
- e. unexpected and superior results from the claimed invention; and
- f. acceptance by others of the claimed invention as shown by praise from others in the field or from the licensing of the claimed invention.

40. I understand that in order for such “secondary considerations” evidence to be relevant to the obviousness inquiry, there must be a relationship or “nexus” between the advantages and features of the claimed invention and the evidence of secondary considerations.

41. I understand that if a claim is not obvious, then the claims that depend from it are not obvious.

42. I have been advised that in an *inter partes* review the claim terms generally should be given their ordinary and customary meaning as a POSA would have understood them at the time of the effective filing date of the claimed invention and in light of the patent and its prosecution history. Furthermore, I have been instructed that a claim's plain language can help guide the interpretation of the claim terms in question, and the manner in which a claim term is used in a claim may be informative of its meaning.

43. Further, I have been informed that in an *inter partes* review proceeding, only claim terms that are actually in dispute need be construed. Thus, terms that are not in dispute, or ones for which alternative constructions would not render a different finding, do not need to be construed.

44. I have also been advised that the claim terms being construed must be construed in light of, and consistent with, the intrinsic evidence of the patent. I understand that a patent's intrinsic evidence includes the patent's prosecution history (which includes the prior art considered by the Examiner(s)), the patent's claims, and the patent's written description as given in the specification of the patent.

45. I have also been advised that when the meaning of a patent's claim term is disputed, the specification of the patent itself is the best guide to the meaning of that claim term. I understand that while embodiments given by the specification can

help understand the meaning of claim terms, preferred embodiments and other examples given in the specification should not further limit the claims by being read into the claim terms being construed.

46. I also understand that an inventor may be his or her own lexicographer by specifically defining his or her own terms within the specification such that they then possess a specific meaning that can be different than the meaning they would otherwise have. I also understand that such an inventor can overcome the plain and ordinary meaning of a given claim term if he or she clearly and explicitly defines or redefines a claim term.

47. I have also been advised that after the patent's claims and specification, the next critical source of evidence regarding the meaning of a patent's claim terms comes from the patent's prosecution history. I understand that the prosecution history contains remarks made by the applicant during prosecution of the application that issues as the patent and those remarks may act to define, redefine, disclaim, or limit the meaning of a claim term, and that if a patentee made statements during prosecution that so limits the scope of a claim term, it is improper for a patent owner to regain the scope given up during prosecution that leads to the issuance of the patent.

48. I have also been advised that in addition to the intrinsic evidence discussed above, extrinsic evidence may also be considered when construing claims, although it is generally not as significant as the intrinsic record itself when understanding the meaning of a claim term. It is my understanding that extrinsic evidence is any relevant evidence that would inform the understanding of the claim terms such as textbooks, dictionaries, expert testimony, treatises, or other like material.

49. I understand that a patent claim must particularly point out and define the boundaries of the subject matter to be protected by that claim. I understand that this requires that a patent claim be sufficiently definite. I understand that a patent claim is indefinite, and thus invalid, if its claims, when read in light of the intrinsic record, fail to inform a POSA with reasonable certainty about the scope of the invention.

## **VI. Level of Ordinary Skill in the Art**

50. In rendering the opinions set forth in this declaration, I was asked to consider the patent claims and the prior art through the eyes of a POSA at the time the claimed invention was made, which I understand is potentially as early as July 11, 2006 (the earliest priority date identified on the face of the '339 Patent). I understand that the factors considered in determining the ordinary level of skill in a

field of art include the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art, and the sophistication of the technology at the time the claimed invention was made. I understand that a POSA is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that a POSA would also have knowledge from the teachings of the prior art, including the art cited below.

51. Based on the technologies disclosed in the '339 Patent, I believe that a POSA would have been a person with a Bachelor of Science degree in electrical engineering, physics, or a related field, with at least two years of industry experience or research, both concerning digital camera system design and image processing at the time the claimed invention was made.

52. Well before July 11, 2006 (the earliest priority date identified on the face of the '339 Patent), my level of skill in the art was at least that of a POSA. I am qualified to provide opinions concerning what a POSA would have known and understood at the time the claimed invention was made, and my analysis and conclusions herein are from the perspective of a POSA as of that date.

## **VII. Claim Construction**

53. For the purpose of this declaration, all claim terms should be given their ordinary meaning to a POSA.

## VIII. Background on the State of the Art

### A. Digital Image Correction In Camera

54. The '339 Patent admits that “software systems [e.g., Photoshop] have been developed that deal with problems post-production” “[i]n order to transcend the optical and digital limits of present camera systems....” (Ex-1001, 6:31-37) and that “[i]n the past, [] optical filtration processes were added after the production process via editing software such as Photoshop. However, in the present system, these combinations of processes are performed in-camera by user-adjusted settings” (*id.*, 12:66-13:3). Thus, the '339 Patent seeks to disclose and claim camera systems that deal with aberrations in-camera. However, such techniques were well known in the art by the time the '339 Patent was filed.

55. For example, as in other prior art discussed herein, Ricoh Technical Paper 31 (Ex-1025), published December 1, 2005, shows using “image processing software embedded in the digital camera” as a “method to correct the aberrations and intensity of a small compact digital camera with a wide-angle zoom lens.” *Id.*, Abstract. Ricoh shows formulas that use adjustable coefficients to correct distortion, peripheral shading and chromatic shift that change with zoom position, aperture value and shooting distance. *Id.*, Summary. Ichiyama discloses two additional methods of correction. The first is by comparing a captured calibration image to an ideal (reference) image in memory, ascertaining the differences between the two

images, and generating a correction equation that is stored in memory and used to correct subsequently captured images. Ex-1021, [005]-[008], [015]-[016]. The second involves using a fast Fourier transform (“FFT”) to transform captured image data to the frequency domain and applying previously derived and stored frequency-domain correction equation to correct the image, and finally, performing an inverse Fourier transform (“IFFT”) to complete the image processing. *Id.*, [026], [029]-[030], Fig. 6.

56. Further, a detailed description of the hardware that could be used to implement image correction in camera is shown in Matsutani. Matsutani describes a controller 22 that includes a microprocessor (CPU), that interacts with a RPU 21 (a DSP) that corrects the images in the digital domain, and a LSI chip (ASIC) 13 that includes the controller 22, RPU 21, and various interfaces to memory. Ex-1006, [0023], [0026]-[0027], [0029]-[0030], Fig. 1. Matsutani teaches the correction of aberrations using a correction algorithm, such as a convolution algorithm (*Id.*, [0043]), for correcting geometric characteristics of image data using a database of coefficient data (correction data). *Id.*, [0007], [0043]-[0046]. Matsutani also teaches that captured image data includes various types of aberrations (chromatic aberration, spherical aberration, coma aberration, astigmatism, field curvature and distortion, etc.) and that known techniques for correcting the effects of these aberrations are disclosed in Ex-1009 (“Ito”) and Ex-1011 (“Shiomi”). Ex-1006, [0003].

57. Ito discloses using a fast Fourier transform as the chromatic aberration correction that is applied by digital signal processing. Ex-1009, [0017]. Shiomi describes a video camera device that corrects chromatic aberration resulting from the use of a zoom lens. Ex-1011, Abstract. Shiomi discloses storing tables of “aberration correction coefficients” indexed to “focal length information  $f_M$  and a focusing lens movement amount  $\Delta N$ ” of the zoom lens. *Id.*, [0021], Figs. 6(b)-(c).

58. In general it was well-known in the art that image correction may be performed in a digital camera using in-camera hardware and software. *See, e.g.*, Ex-1020, 2:33-35 (teaching that “[a]n electronic camera can use a programmable digital processor controlled by software.”), 1:65-2:2 (teaching that “the camera contains EPROM memory with code for in-camera white balance and gamma correction and also stores the compiled code which is used (by the computer) to operate the camera and to process the images from sensor color filter array to obtain a full resolution, color corrected image.”).

## **B. Storage of Correction Data**

59. It was known that this type of correction information can be stored in the camera lens itself, the camera body, or in devices connected to the camera. *See* Ex-1008, 12:28-40, 13:6-12, 13:28-34, 14:4-38, Fig. 2 (teaching an “image processing apparatus 14” with a “lens characteristic data supply subsection 60” that “has a memory that stores information about the lens characteristics associated with

various camera models, specifically information about the characteristics of lateral chromatic aberrations and distortions of various lenses,” including correction coefficients); Ex-1020, 4:58-5:10 (teaching that “image processing software, look-up tables, matrices, compression tables, dynamic range optimization tables, and other files capable of affecting the captured image data can be included in the digital storage device.”).

### **C. Optical Aberration Corrections**

60. All real lenses produce images with various combinations of distortions and artifacts. These generally are called “aberrations.” Designers of lenses do what they can to minimize aberrations, but must balance that desire to minimize aberrations against issues of size, complexity, and cost of the designed lens. The corrections may relate to known lens issues. These include, in part, the five Seidel aberrations, known to lens designers since their mathematical description was published in 1857 by Ludwig von Seidel. The Seidel aberrations are (1) spherical, (2) comatic, (3) astigmatism, (4) curvature of field, and (5) distortion.

61. These and other image defects arising due to the construction of the lens were well known in the art. *See, e.g.*, Ex-1013, 2:10-14 (“It is preferable that the image quality deterioration corrected by the lens characteristic correction unit is at least one of a chromatic aberration of magnification, a distortion aberration, defocusing and a decrease in marginal lumination.”).

#### **D. Focal Length**

62. The distance from the center of the lens to the image focal point (i.e., image sensor surface) is known as the focal length. As focal length changes, the amount of the subject captured by the lens also changes.

63. It was well-known in the art to use image correction data corresponding to user-adjustable the focal length of a lens to process image corrections. *See* Ex-1005, [0058], [0060], [0084], [0177] (teaching that the focal length of a lens is user adjustable and a shading correction circuit 123 that can perform a shading correction with reference to a plurality of correction tables stored in the shading ROM 1532 for different optical conditions such as focal length at the time of imaging.); Ex-1013, 2:59-60, 3:5-10, 4:16-20, 4:29-33, 6:23-30, 6:47-52, 8:27-41 (teaching a camera that can correct aberrations based on lens characteristics corresponding to lens data (e.g., switchable focal length) stored for every interchangeable lens, and in case of a zoom lens for a plurality of focal lengths.). The use of correction tables to correct aberrations in fixed focal length lenses was also well known as of the Priority Date. *See* Ex-1018 at 40:9-24, 40:44-47 (disclosing correcting aberrations in fixed focal length lens). Enomoto III teaches that correction tables for zoom and fixed focal length lenses would be the same, except zoom lenses require additional correction tables to account for each focal length. *Id.*, 40:44-47.

## **E. Aperture Settings**

64. Most camera lenses incorporate an aperture (often realized as an iris diaphragm) which can be opened or closed to varying degrees to control the overall amount of light taken in by the lens. Some cameras permit the user to adjust the aperture, but most current cameras, especially simpler ones, adjust the aperture automatically.

65. The aperture setting of a lens is typically described by an “f-number” or “f-stop” which is the ratio of the lens’ focal length to the diameter of the aperture. Larger f-numbers describe smaller aperture settings, which allow less light through the lens to form the image.

66. It was well known in the art that aperture settings are user-adjustable image capturing parameters. *See, e.g.,* Ex-1020, 5:11-15, 7:16-23, 7:38-50 (teaching a camera with user-adjustable aperture value).

## **F. Exposure Mode**

67. In a digital camera, exposure is the amount of light per unit area reaching the surface of an image sensor. Exposure depends on shutter speed and lens “f-number” (aperture). In manual mode, the photographer adjusts the lens aperture and/or shutter speed to achieve the desired exposure. In automatic exposure (auto exposure or AF) mode, these parameters are adjusted automatically in the camera.

68. The auto exposure technology used in a camera as an image capturing setting was well-known in the art. *See, e.g.*, Ex-1005, [0058], [0074], [0084], [0101], [0134], [0135], Figs. 8, 9 and 14 (teaching a normal exposure mode and a gradation control processing mode, which is the auto-exposure mode, in a digital camera.).

### **G. Fast Fourier Transform**

69. Fast Fourier Transform is known as a filter used in digital cameras to improve image quality by converting the image signal into the frequency domain for filtering.

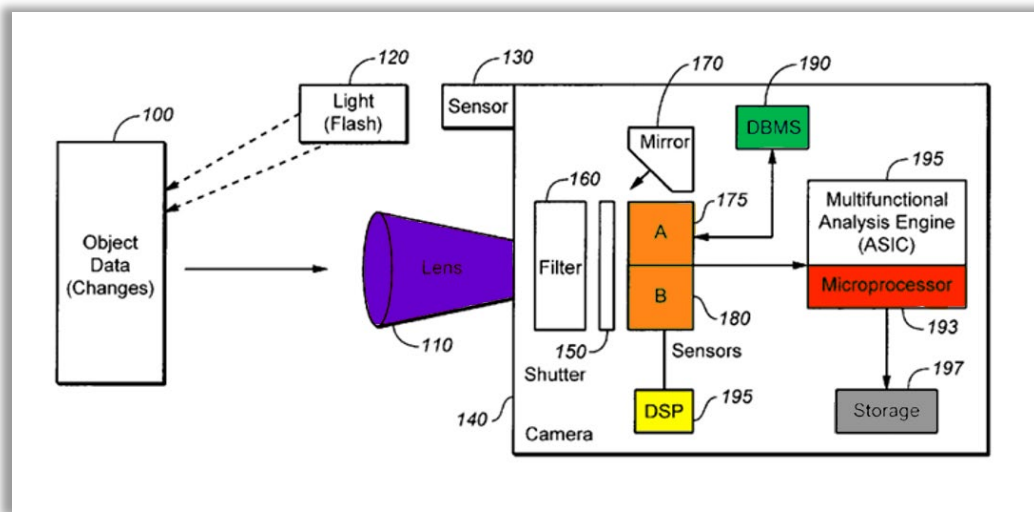
70. And it was well-known in the art to use FFT to correct aberrations, like chromatic aberrations. *See, e.g.*, Ex-1009, [0010], [0017], [0020] (teaching a digital video camera that applies a FFT to perform chromatic aberration corrections based on the correction values stored in memory corresponding to focal length); Ex-1021, [007], [026], [029]-[030], Fig. 6 (teaching using a FFT to transform captured image data to the frequency domain and applying previously derived and stored frequency-domain correction equation to correct chromatic aberrations, and finally, performing an IFFT to complete the image processing); Ex-1023, Abstract, 1:7-11, 1:31-49, 3:1-12, 6:3-20, 9:36-67 (teaching a filter used to correct chromatic aberrations in image taken by a camera using the fast Fourier transform algorithm.).

## **IX. Overview Of The '339 Patent**

### **A. Summary**

71. 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.

72. 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.1001, Fig. 1.

## B. Relevant Prosecution History

73. 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.

74. 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.

75. A notice of allowance (NOA) issued two weeks after the applicant’s response. *Id.*, 82. The ’339 Patent issued on May 28, 2013.

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

## **X. Overview of the Prior Art References**

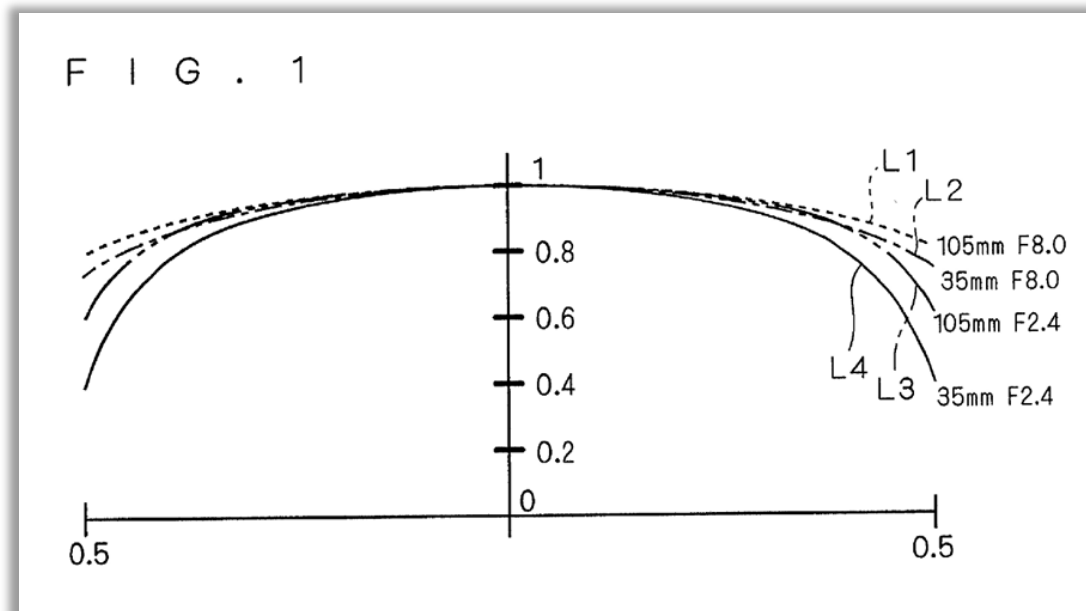
77. I have reviewed and am familiar with the following prior art references: (1) Niikawa, (2) Enomoto, (3) Ito, (4) Matsutani, (5) Shiomi, and (6) Enomoto II.

### **A. Niikawa**

78. 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].

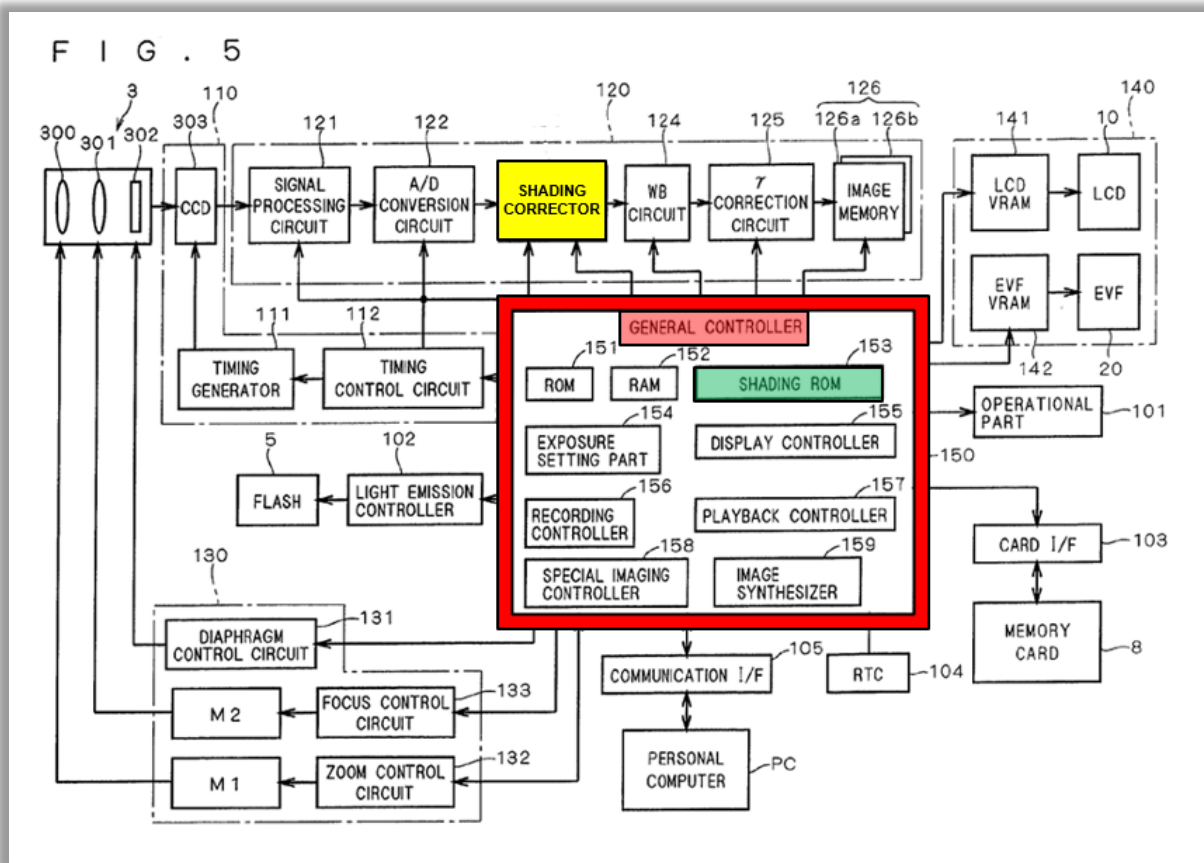
79. Figure 1 depicts an example of how shading can influence an image captured using a digital camera with lenses at different focal lengths and “f-numbers.” Ex-1005, [0057]-[0060]. As shown in Figure 1, focal length (represented in mm) and f-number influence shading. *Id.*, [0060].



Ex-1005, Fig. 1.

80. As seen in Figure 5 (processor implementation shown below), Niikawa teaches a signal processor 120 with a shading corrector (yellow) that corrects shading due to optical conditions. Ex-1005, [0082]. 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 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).

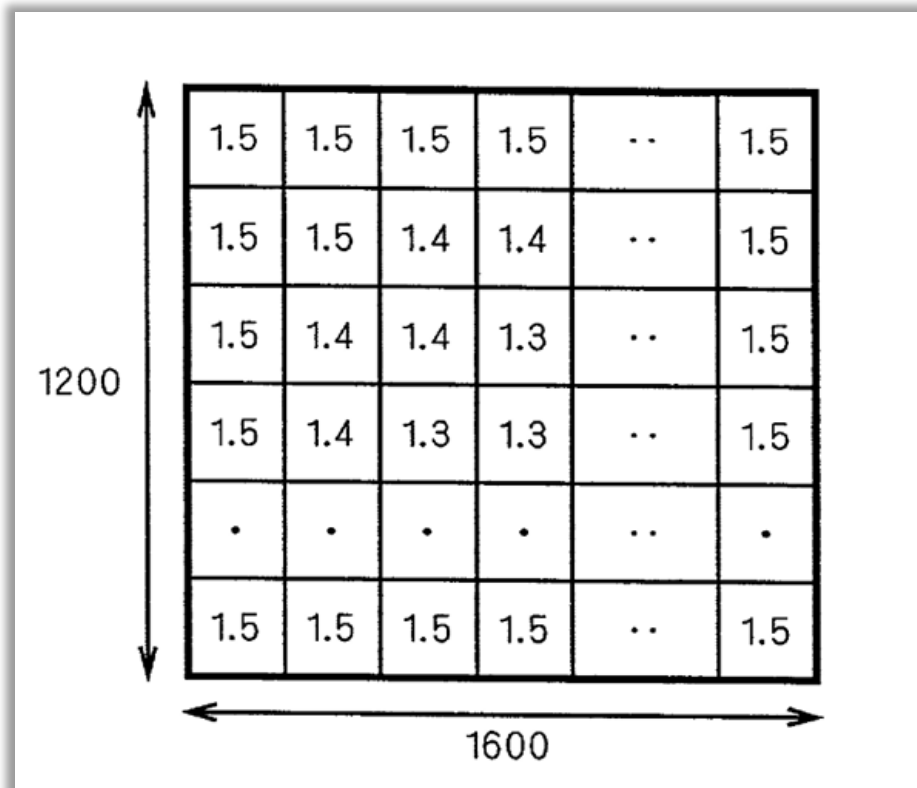
81. Specifically, claim 1 of Niikawa recites a “shading corrector.” Ex-1005, Claim 1. Claim 2 of Niikawa, which is dependent on claim 1, recites that the “shading corrector” can be implemented as a “coefficient processing hardware circuit.” *Id.*, Claim 2. Alternatively, claim 5 of Niikawa, which is dependent on

claim 4, which depends from claim 1, recites that the “shading corrector” can be implemented as a “processor.” *Id.*, Claims 4, 5. Claim 4, from which, claim 5 depends separately recites a controller. *Id.*, Claim 4. A POSA reading Claim 5 of Niikawa would understand that the processor of the shading corrector is separate from the controller, just as the shading corrector of Figure 5 is separate from the general controller. Thus Niikawa discloses that the shading corrector can be implemented as either a hardware circuit or a processor.

82. 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. At a minimum, it would have been obvious to a POSA to use a processor to perform the shading correction functionality. Such motivation is provided by Niikawa’s claims themselves. Additional motivations are explained further below.

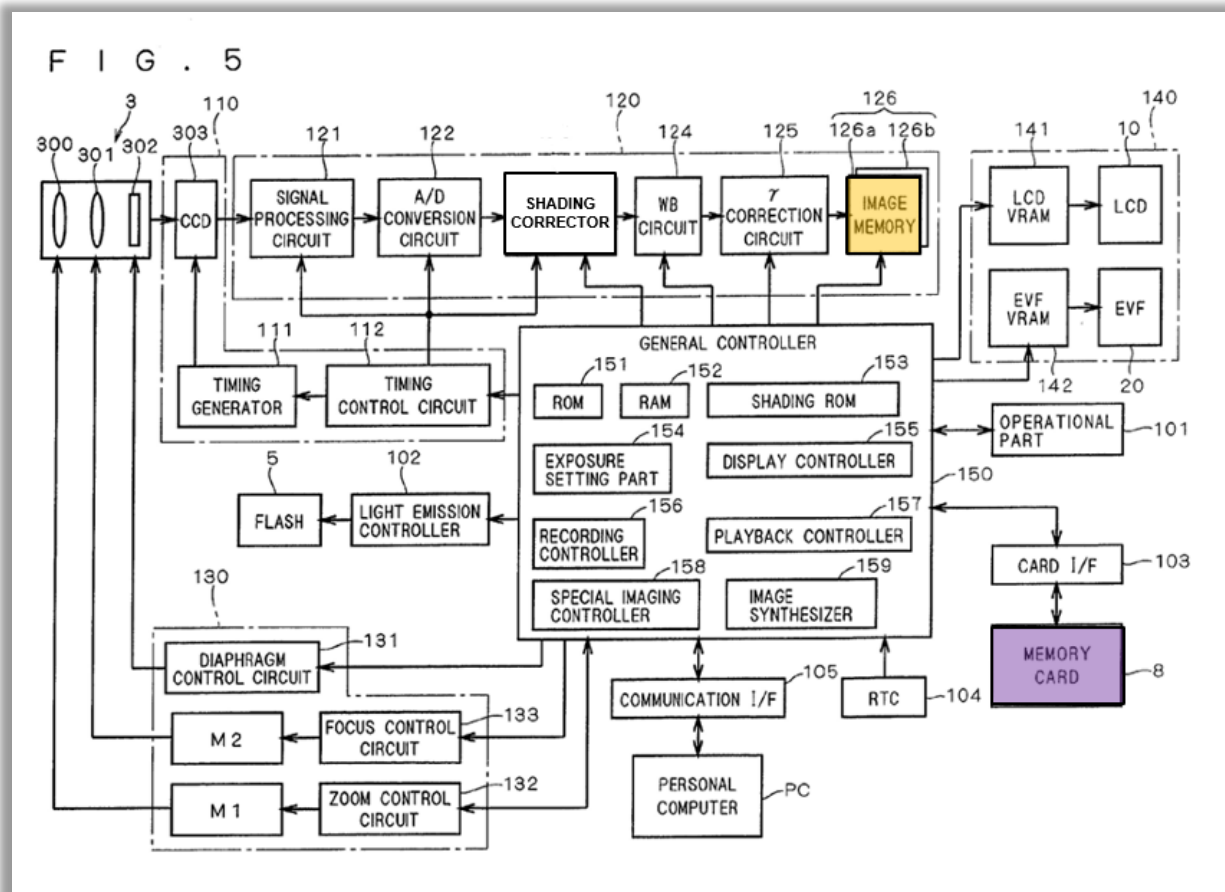
83. The general controller 150 includes programs for controlling camera functions and the components of the digital camera 1. Ex-1005, [0096]. Based on the optical conditions of the lens, such as focal length and f-number, the general controller 150 selects a “correction table” with inverse correction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

84. 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.

85. 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).



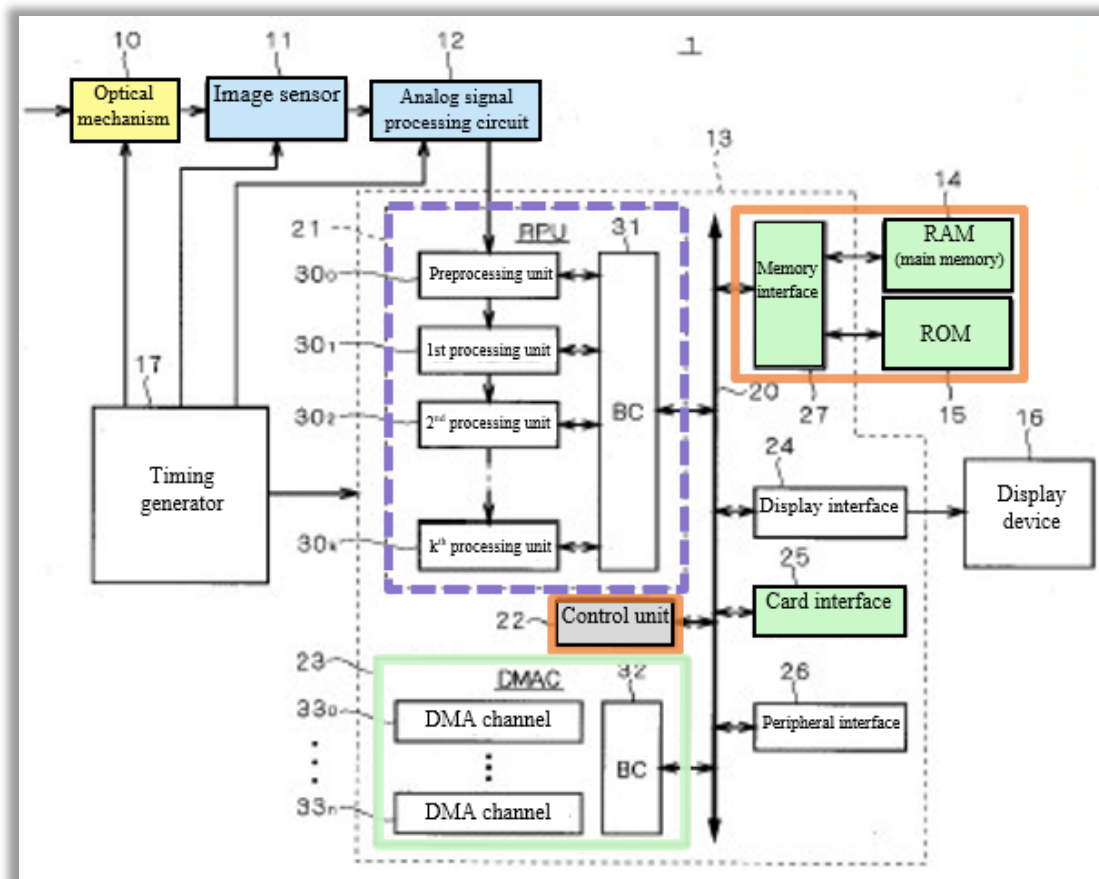
Ex-1005, Fig. 5 (with shading corrector processor).

86. 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.

## **B. Matsutani**

87. 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.

88. 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.

89. 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-1016, 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.

### C. Enomoto

90. 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.

91. 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.

**D. Ito**

92. 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.

93. 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.

**E. Shiomi**

94. 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  $\Delta N$ ” of the zoom lens. *Id.*, [0021], Figs. 6(b)-(c).

95. 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.

**F. Enomoto II**

96. 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.

97. 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.

## **XI. The Challenged Claims Are Unpatentable**

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

98. It is my opinion that claims 1, 3, and 5 are obvious over (a) Niikawa. It also my opinion that claims 1-3, 5, 14-15, and 17-18 are obvious over (b) Niikawa in view of Enomoto.

#### **1. Independent Claim 1**

##### **a. Element [1pre]**

**“A digital imaging system for correcting optical image aberrations comprising:”**

99. 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.

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

##### **b. Element [1A]**

**“a digital camera mechanism, an optical lens mechanism, a digital sensor, a microprocessor, a digital signal processor, system software, a database**

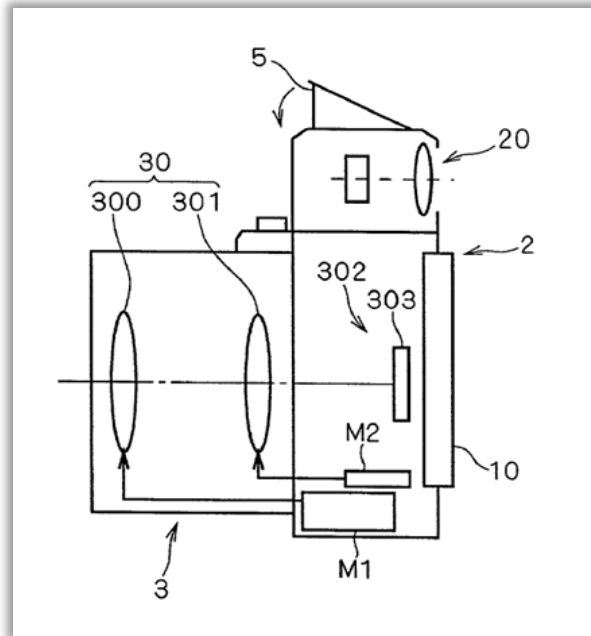
**management system and a memory storage sub-system;”**

101. It is my opinion that Niikawa teaches or suggests [1A].

102. Element [1A] recites “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.” I address each of the sub-elements in turn.

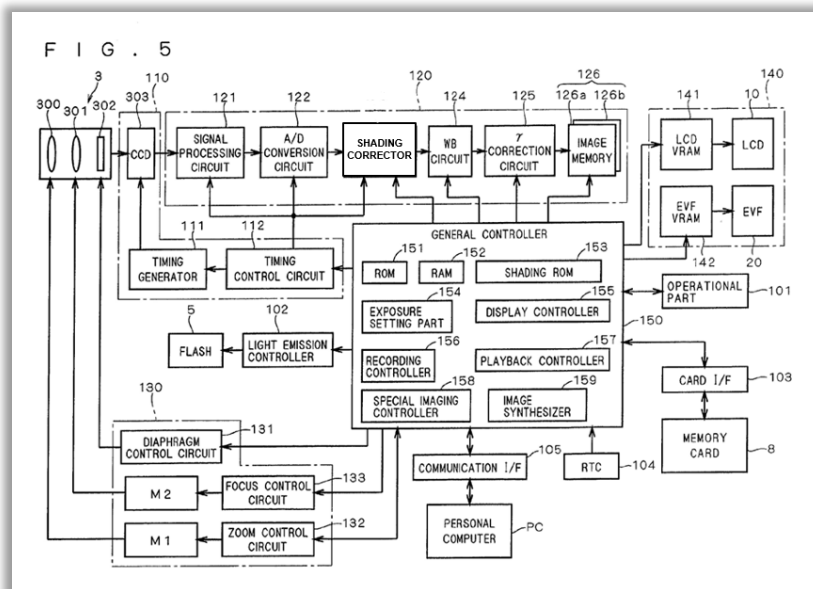
**(1) [1A-1] Digital Camera Mechanism**

103. 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-1005, Fig. 3.

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

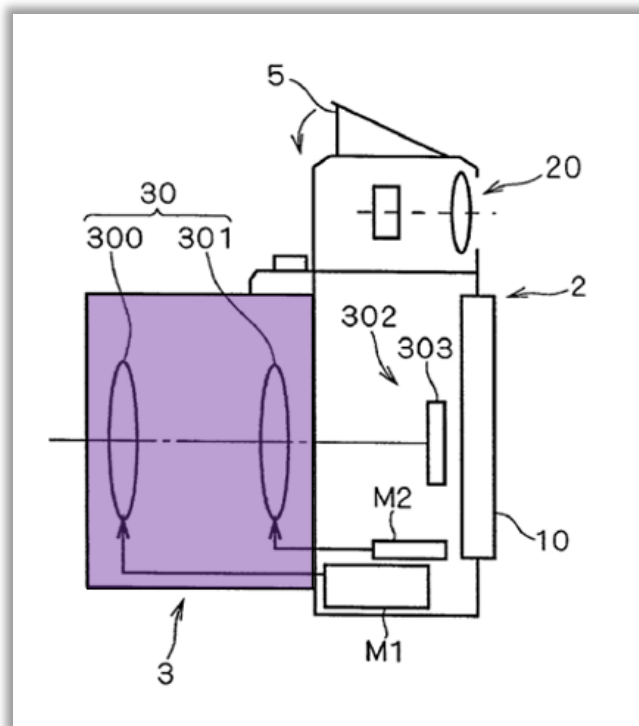


Ex-1005, Fig. 5 (with shading corrector processor).

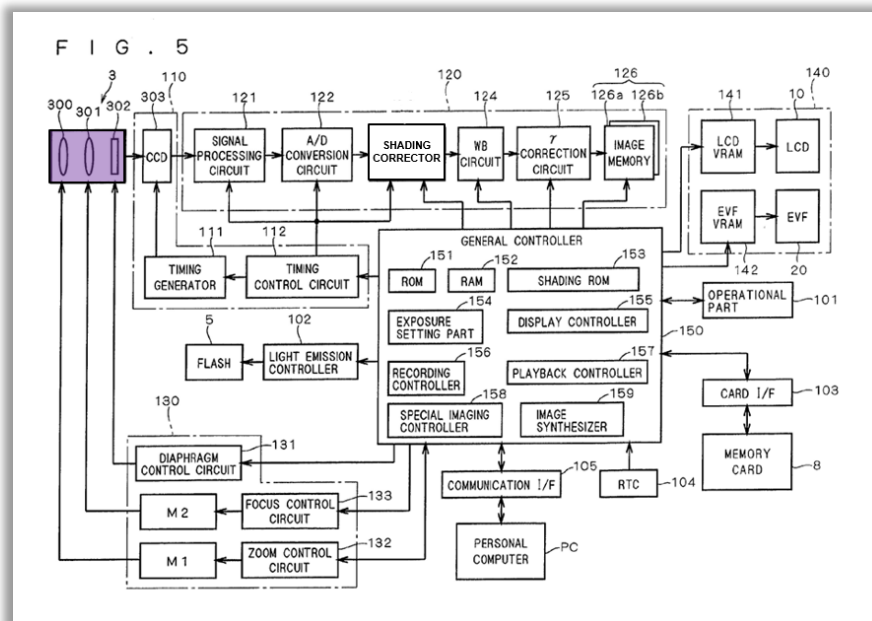
105. Niikawa discloses a digital camera mechanism (digital camera 1).

**(2) [1A-2] Optical Lens Mechanism**

106. 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-1005, Fig. 3.

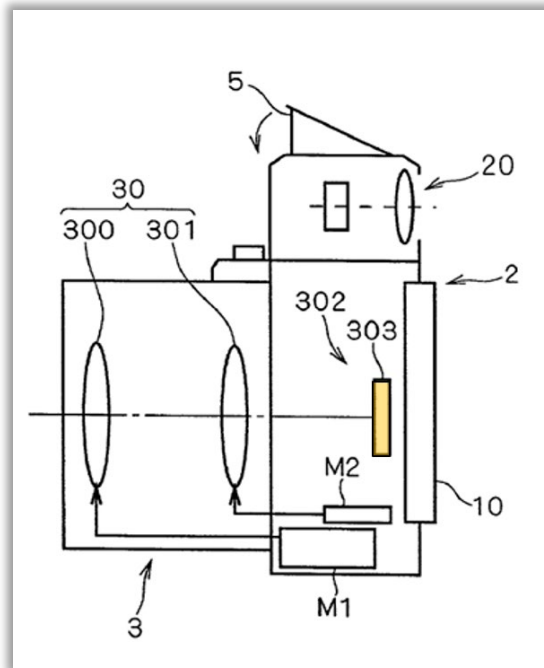


Ex-1005, Fig. 5 (with shading corrector processor).

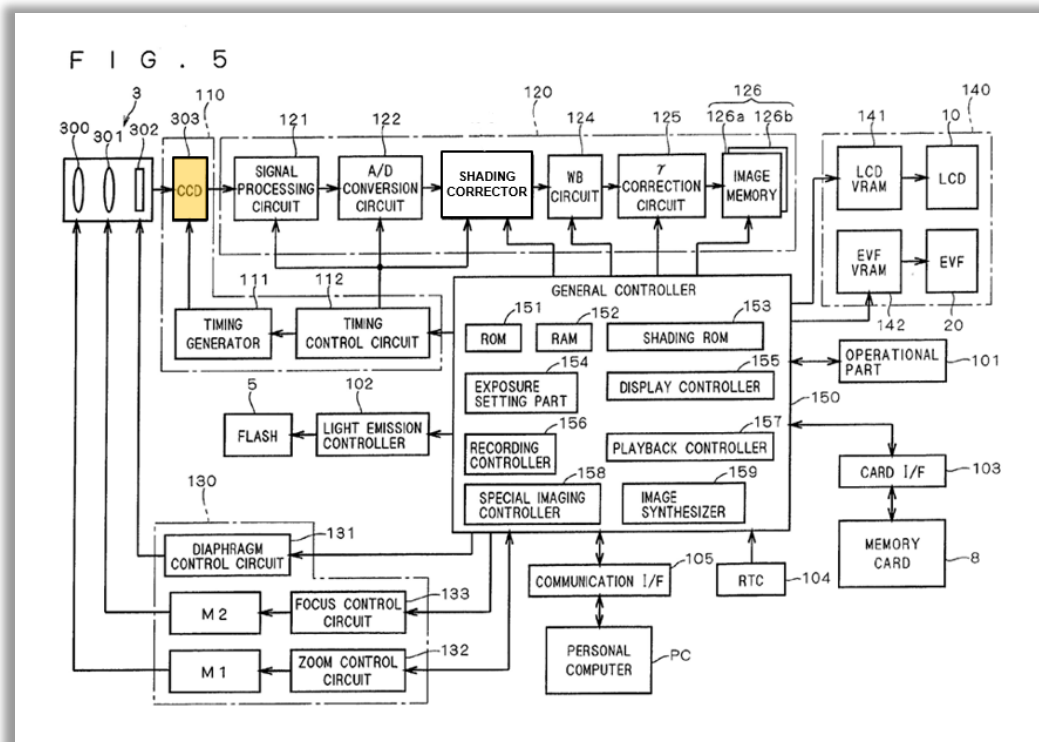
107. Niikawa discloses an optical lens mechanism (imaging lens 3).

### (3) [1A-3] Digital Sensor

108. 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”). Notwithstanding that a CCD provides an analog signal that requires digitization, the ’339 specification identifies a CCD as a “digital sensor[]” in which “photons are recorded by electrically charged pixels.” 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-1005, Fig. 3.

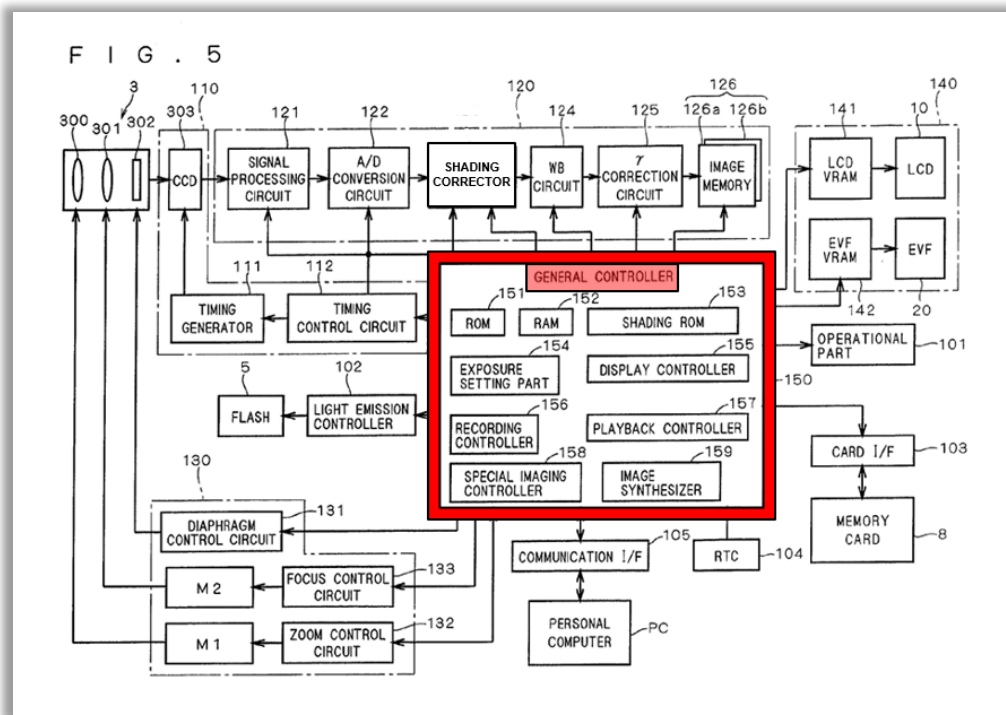


Ex-1005, Fig. 5 (with shading corrector processor).

109. Niikawa discloses a digital sensor (CCD 303).

**(4) [1A-4] Microprocessor**

110. 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. A microcomputer includes central processing unit, which is a microprocessor, and other components such as memory and input/output interfaces. The microprocessor is responsible for executing software instructions, processing data, and controlling components (such as memory, etc.). A POSA would have understood that the exposure and playback functions are managed by a microprocessor within a microcomputer.

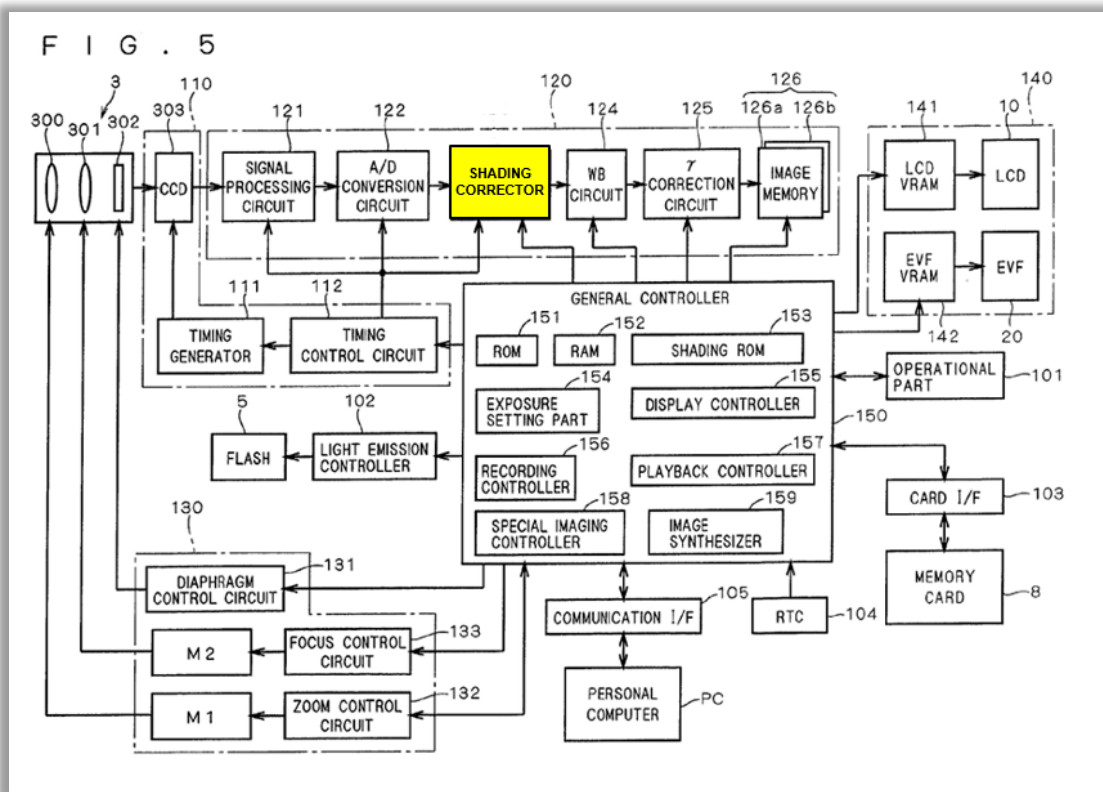


Ex-1005, Fig. 5 (with shading corrector processor).

111. Niikawa discloses a microprocessor (general controller 150).

### (5) [1A-5] Digital Signal Processor

112. 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-1005, Fig. 5 (with shading corrector processor).

113. 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. *See* Ex-1006, [0023], [0026]-[0027], [0029], [0035], Fig. 1 (disclosing a CPU (microprocessor),

real-time processing circuit (DSP), and large-scale integrated circuit (ASIC) for correcting aberrations). Unlike processors, the operation of a hardware multiplier like shading corrector 123 cannot be changed or upgraded because they are implemented in fixed hardware. As such, a POSA who wanted to implement to reprogram or upgrade a processing function would have used a processor instead of the functionally fixed shading correction circuit.

114. 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).

115. 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.

116. Thus, Niikawa discloses a digital signal processor (shading corrector with a processor).

## **(6) [1A-6] System Software**

117. 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

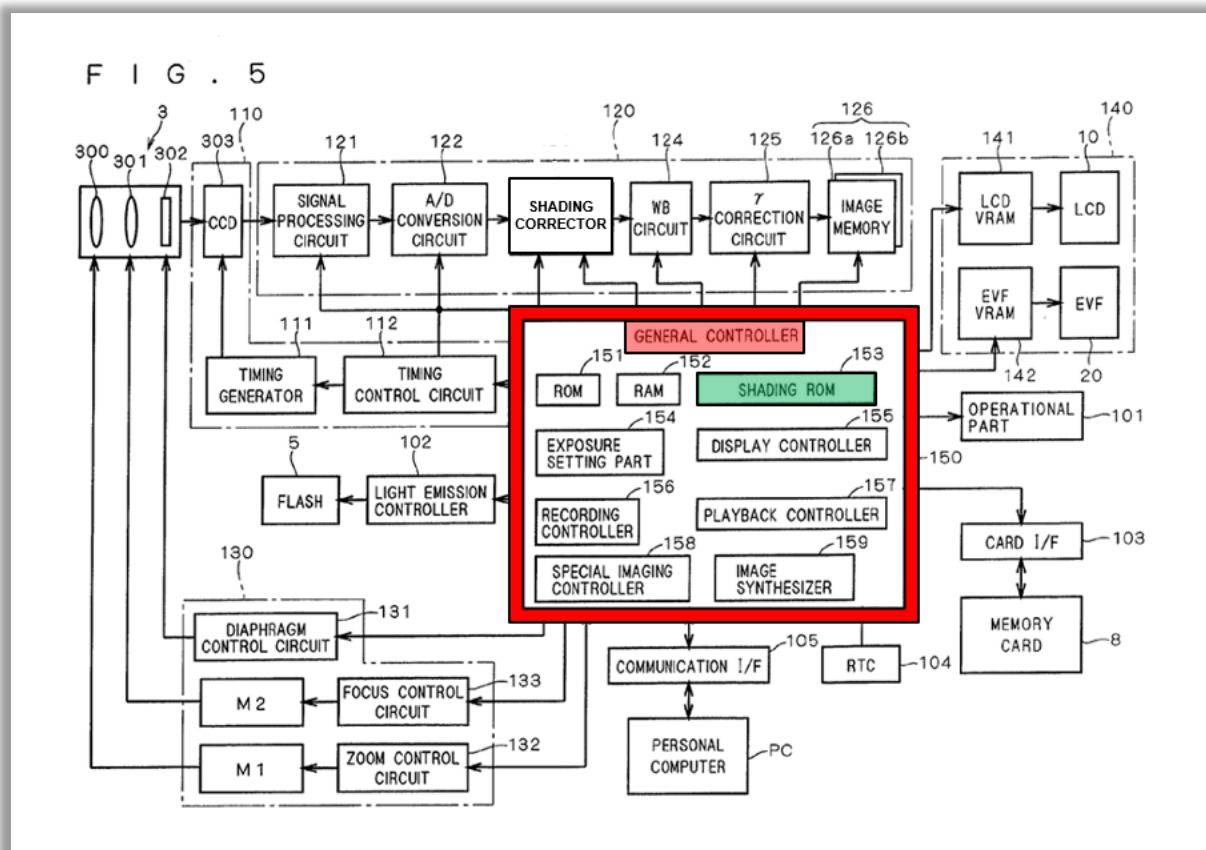
to a program product containing a program for executing an image processing.”). The ’339 Patent describes “processing software” as “stored in either a microprocessor or an ASIC.” Ex-1001, 21:67-22:1. A POSA would have understood that the programs stored in ROM 151 were system software.

118. Thus, Niikawa discloses system software (programs stored in ROM 151).

#### **(7) [1A-7] Database Management System**

119. Niikawa discloses that digital camera 1 has a general controller 150 (red) that 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 1,920,000 pixels of 1,600 pixels×1,200 pixels of the 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.”). Niikawa’s correction table is a structured set of data storing correction coefficients that are accessed and used by the general controller to correct image data. A POSA would have thus understood

that the correction tables, which store data in a structured way that serves a particular function(s), is a database.



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

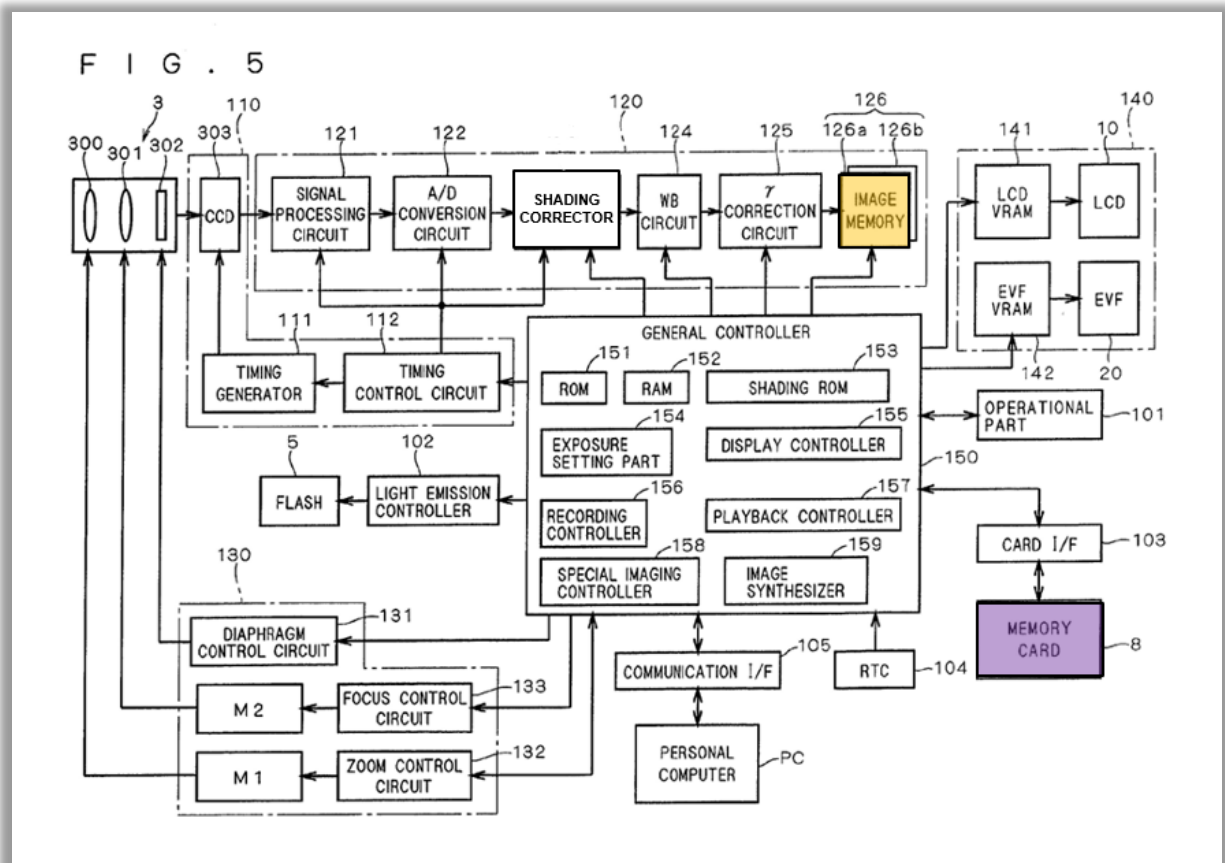
120. Despite other limitations in the claim reciting a “database” without antecedent basis, to the extent the claimed “database management system” (“DBMS”) is not limited to a database, Niikawa also discloses a DBMS, as disclosed in the ’339 Patent. General controller 150 includes ROM 151 which stores 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.

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

#### **(8) [1A-8] Memory Storage Sub-System**

122. 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.



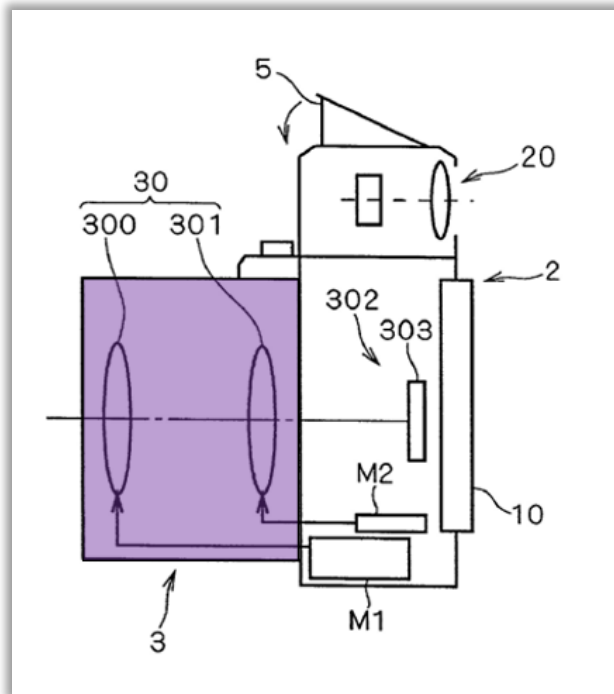
Ex-1005, Fig. 5 (with shading corrector processor).

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

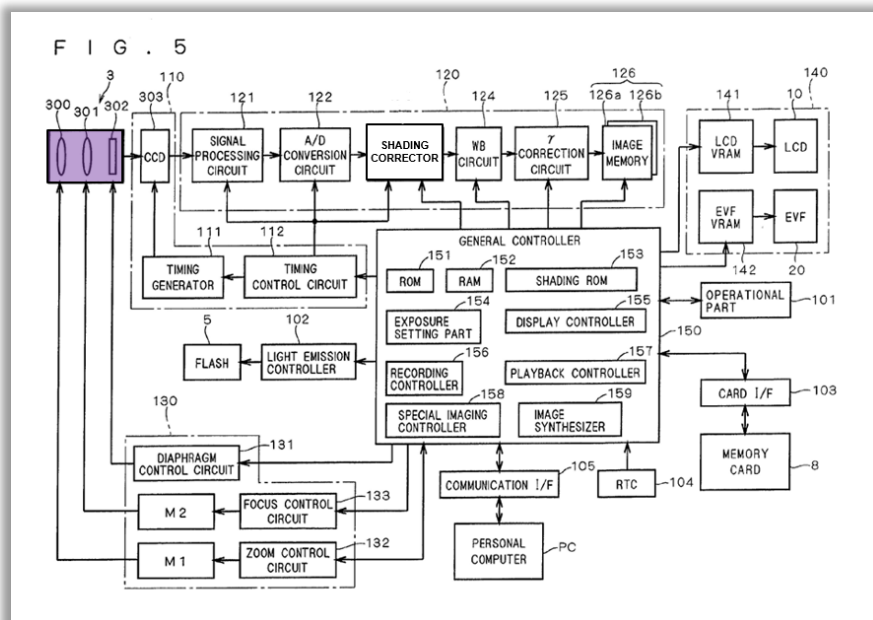
**c. Element [1B]**

**“wherein the optical lens mechanism is a fixed focal length lens;”**

124. 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-1005, Fig. 3.



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

125. 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”).

126. 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. Cameras support interchangeable lenses because each lens has benefits and drawbacks. Zoom lenses allow quick adjustment of composition that allows a user deal with the demands of a changing environment where there is a need to quickly adapt to different shooting conditions. On the other hand, while fixed focal length (typically referred to as a prime lens) do not have this advantage, they will generally have a higher optical quality and fewer aberrations due to their less complex design. A typically user of a camera with interchangeable lenses will have several types of lenses, including both zoom and prime lenses so that can choose the lens that is most appropriate for the situation.

127. 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). 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”).

128. 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.

129. 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).

130. 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.

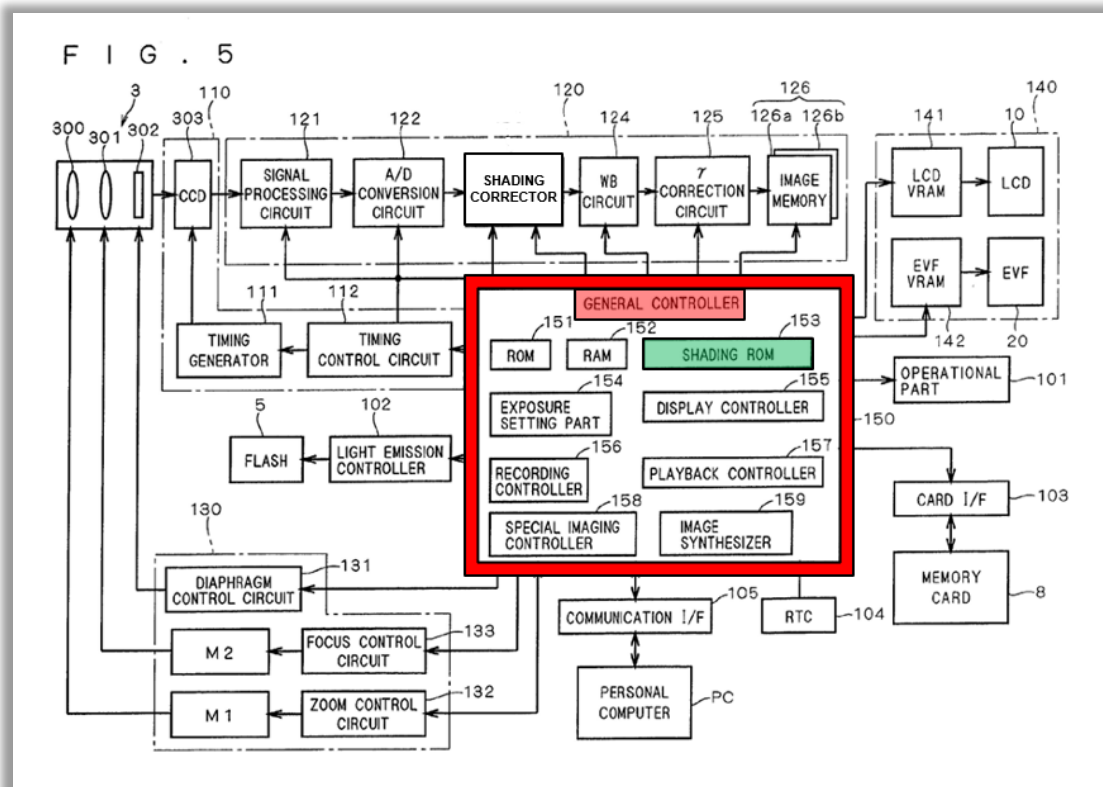
131. Thus, Niikawa discloses and renders obvious wherein the optical lens mechanism (imaging lens 3) is a fixed focal length lens.

**d. Element [1C]**

**“wherein a microprocessor uses system software to identify at least one optical aberration by accessing the database;”**

132. 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 those specific optical aberrations and are used to correct those aberrations. *Id.*, [0082]-[0085].



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

133. The optical conditions of the lens 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 adjustment of the aperture value. The focal length of the lens affects vignetting too. Lens characteristics, such as focal length, aperture, and design, significantly influence optical aberrations. Short focal lengths can exacerbate spherical aberration and chromatic aberration, while longer

focal lengths generally reduce these effects. Larger apertures increase spherical aberration and coma by utilizing more of the lens surface, including the periphery where these issues are more pronounced. Lens design, including the use of aspherical and low-dispersion elements, helps correct issues like astigmatism, coma, and chromatic aberration. Advanced coatings and materials further reduce color fringing and distortion. Overall, the interplay of these characteristics determines the quality and clarity of the resulting image. 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 of the aperture values would be 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.

134. 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.

135. 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. 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.

136. A POSA further 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 processor 14) in the same way (correcting multiple aberrations).

137. 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.

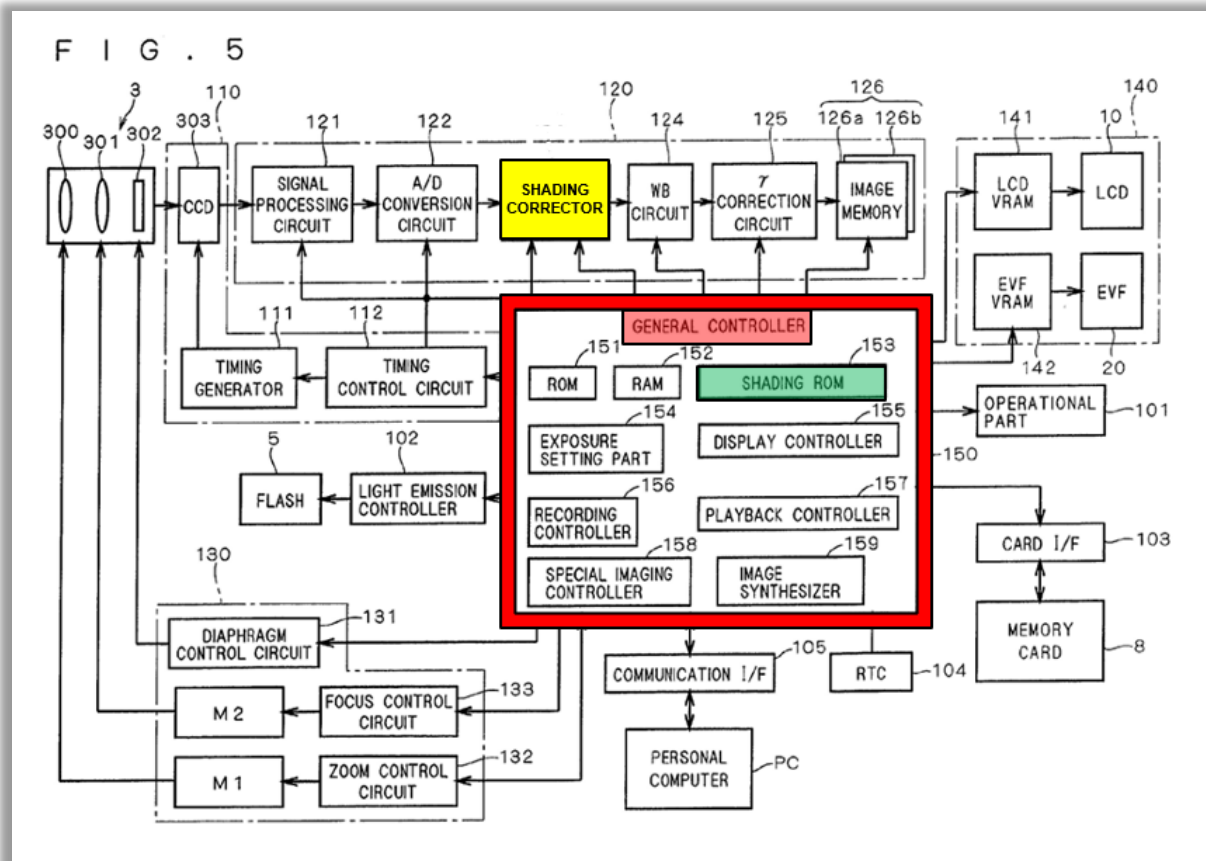
138. Thus, Niikawa discloses and Niikawa in view of Enomoto render obvious wherein a microprocessor (general controller 150) uses system software (programs stored in ROM 151) to identify at least one optical aberration (a shading aberration for a specific lens type, focal length, and f-number) by accessing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

**e. Element [1D]**

**“wherein the microprocessor uses the database to identify at least one algorithm to use to correct the at least one optical aberration;”**

139. 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-1005, Fig. 5 (with shading corrector processor).

140. 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.

141. By doing so, the general controller would identify and send the algorithm to the DSP (the processor of the shading corrector), in conjunction with, and in the same way that general controller 150 identifies and sends the inverse correction coefficients. This would ensure that all necessary data for shading correction, including both the correction coefficients and the algorithms applying them, is centralized. This simplifies the processing workflow, which provides additional motivation for a POSA to implement this approach.

142. 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).

143. 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).

144. 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.

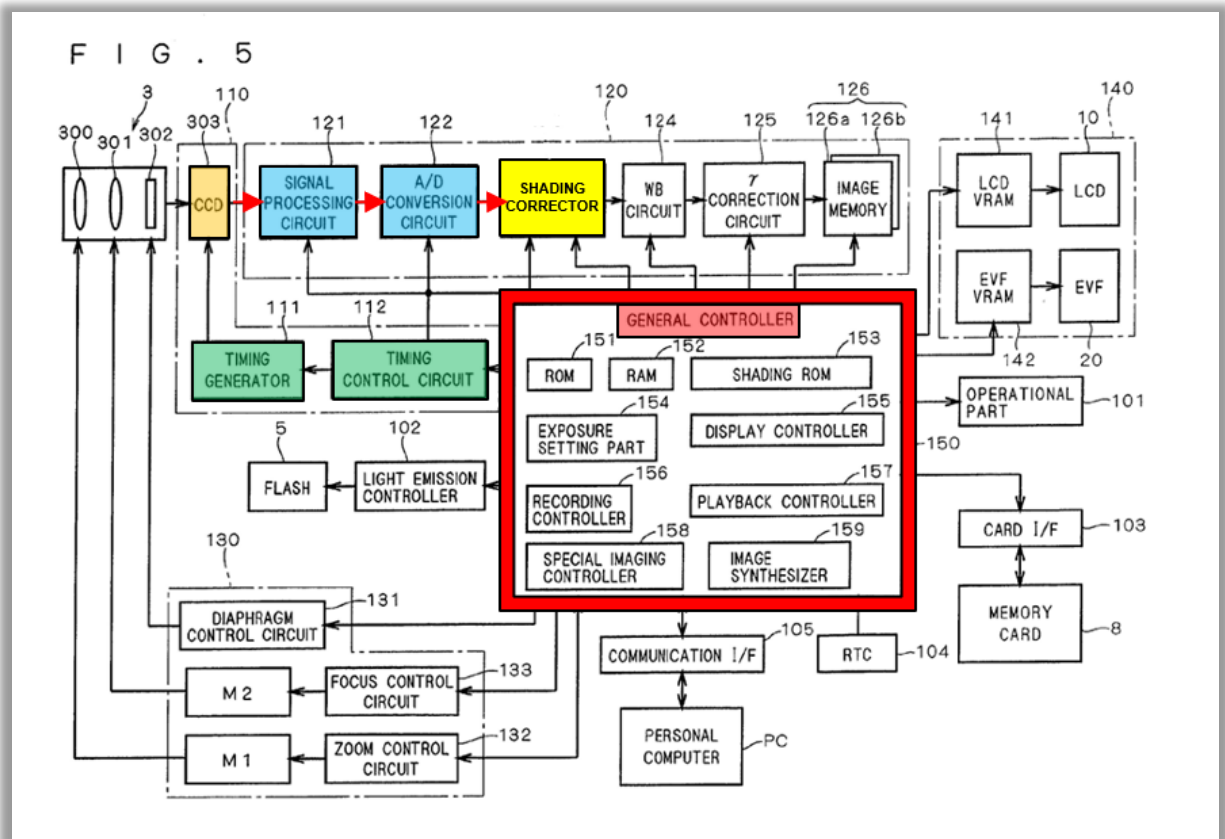
145. Niikawa discloses and Niikawa in view of Enomoto render obvious wherein the microprocessor (general controller 150) uses the database (correction

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).

**f. Element [1E]**

**“wherein when the image file is captured by the digital sensor the digital file is forwarded to the digital signal processor;”**

146. 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-1005, Fig. 5 (with shading corrector processor).

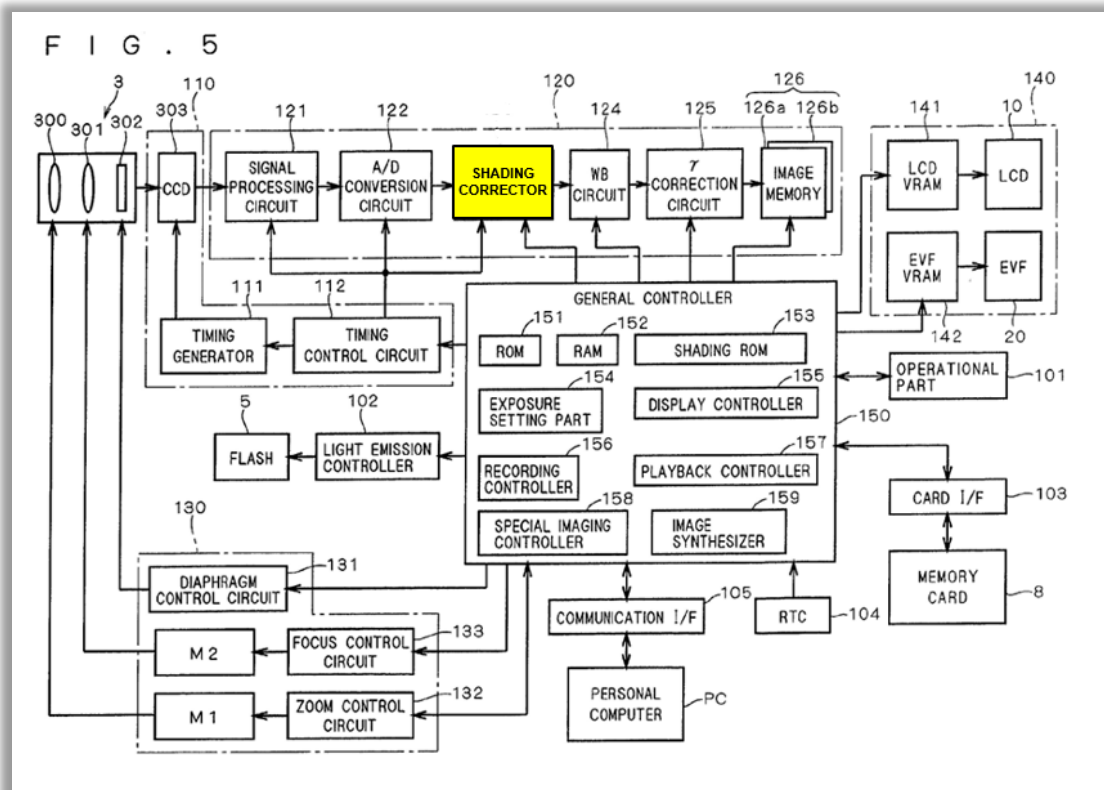
147. Thus, Niikawa discloses wherein when the image file (image data) is captured by the digital sensor (CCD 303) the digital file is forwarded to the digital signal processor (shading corrector).

**g. Element [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”**

148. 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-1005, Fig. 5 (with shading corrector processor).

149. A decrease in light farther away from a center of a lens is known as vignetting. 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.

150. Thus, 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).

**h. Element [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.”**

151. 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  $\gamma$  correction before storing the modified data in memory (*i.e.*, image memory 126 and/or memory card 8). Ex-1005, [0079], [0086], [0109]-[0110].

152. Thus, 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).

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

## **2. Claim 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.**

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

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

## **3. Claim 3**

**The system of claim 1:**

### **a. Element [3A]**

**“wherein the optical aberration is vignetting;”**

156. 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 (reduction in brightness at the periphery of an image compared to the image center resulting in the image appearing darker around the edges). *See* claim [1F].

157. Thus, Niikawa discloses wherein the optical aberration is vignetting.

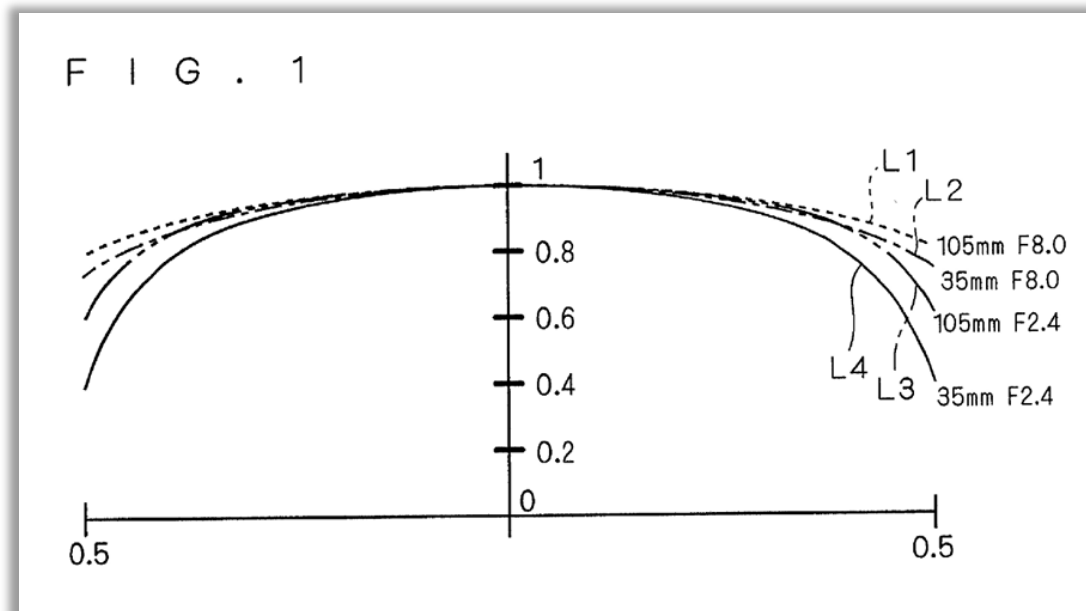
**b. Element [3B]**

**“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”**

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

159. 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 correction coefficient is the inverse of the amount by which shading affects each pixel, and multiplying each pixel’s brightness level by this inverse coefficient increases the brightness of pixels that were darkened due to shading. The shading corrector thereby lightens the corners of the image by applying the multiplication algorithm.



Ex-1005, Fig. 1.

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

**c. Element [3C]**

**“wherein the image exposure is optimized to correct the vignetting.”**

161. 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.

162. Thus, Niikawa discloses wherein the image exposure is optimized to correct the vignetting.

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

**4. Claim 5**

**The system of claim 1:**

**a. Element [5A]**

**“wherein each lens type is registered in the camera database;”**

164. 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.

165. 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. A POSA thus would have been motivated to register lens types to identify different aberrations based on those lens types as well. 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.

166. Using lens type to index the database also provides a quick and efficient way to retrieve specific correction profiles and settings tailored to each lens's unique characteristics. Because different lenses have distinct optical properties that affect image quality, indexing by lens type ensures that the system can immediately apply

the most relevant corrections for issues like distortion, chromatic aberration, and vignetting. This approach streamlines the image processing workflow, reduces processing time, and enhances accuracy, leading to consistent high-quality results regardless of the lens used. Additionally, it allows for easy updates and management of the database as new lenses are added or existing ones are modified.

167. Moreover, databases are well-suited for handling this type of data, offering scalability, reliability, and speed in retrieval. Given the predictable nature of lens characteristics and the effectiveness of using this data for image correction, transitioning to a database system would likely result in more efficient, accurate, and streamlined image processing, thereby supporting the overall success of the system.

168. 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). 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.

169. 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.

170. Thus, 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).

**b. Element [5B]**

**“wherein the multiple optical aberrations of each lens is listed in the database;”**

171. Niikawa discloses and Niikawa in view of Enomoto render obvious this limitation as explained above in [1C] and [5A].

172. Thus, 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).

**c. Element [5C]**

**“wherein the filtration solutions to the lens optical aberrations are listed in the database;”**

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

174. Thus, 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).

**d. Element [5D]**

**“wherein the filtration of each lens optical aberration is applied by the digital signal processor; and”**

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

176. Thus, 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).

**e. Element [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.**

177. Niikawa discloses this limitation for the reasons explained in [1G].

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

**5. Independent Claim 14**

a. Elements [14pre]-[14A-8]

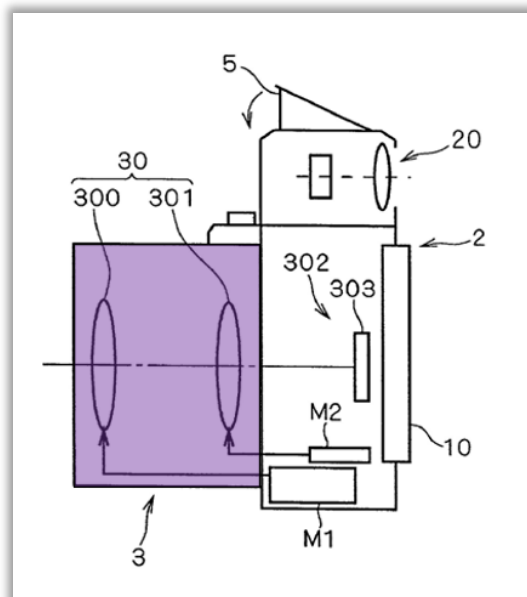
**“A digital imaging system for correcting image aberrations comprising: a digital camera mechanism, an optical lens mechanism, a digital sensor, a microprocessor, a digital signal processor, system software, a database management system and a memory storage sub-system;**

179. Niikawa discloses [14pre]-[14A-8] for the reasons explained above in [1pre]-[1A-8].

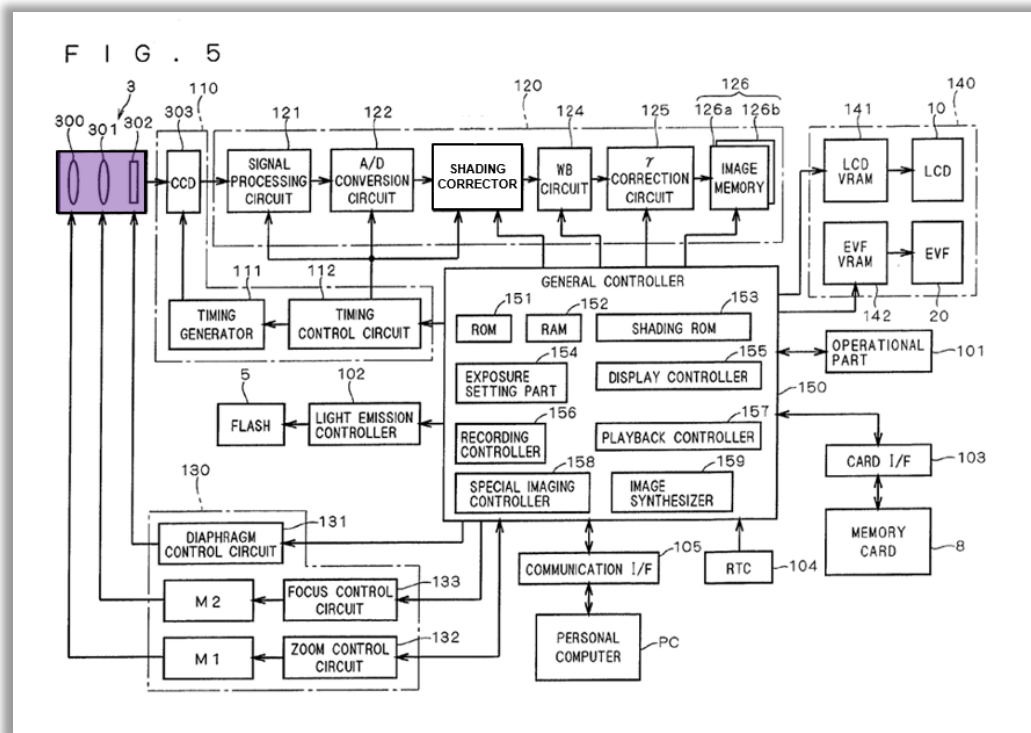
b. Element [14B]

**“wherein the optical lens mechanism is a zoom lens;”**

180. 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-1005, Fig. 3.



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

181. Thus, Niikawa discloses wherein the optical lens mechanism (imaging lens 3 including zoom lens 300) is a zoom lens.

**c. Element [14C]**

**“wherein the zoom lens changes focal length positions;”**

182. 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].

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

**d. Element [14D]**

**“wherein when the image file is captured by the digital sensor the file is forwarded to the digital signal processor and to memory;”**

184. 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).

185. Thus, 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).

**e. Element [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;”**

186. 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. By identifying the optical conditions at the time of imaging, general controller 150 identifies the specific optical aberration to correct in the database.

187. Thus, 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).

**f. Element [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;”**

188. 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.

189. Thus, 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).

**g. Element [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”**

190. 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.

191. Thus, 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).

**h. Element [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.”**

192. Niikawa discloses this limitation for the reasons explained above in [1A-8], [1G], and [14G].

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

**6. Claim 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.”**

194. Niikawa discloses this limitation for the reasons explained above in

[3A].

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

## **7. Claim 17**

**“The system of claim 14: wherein each focal length of a zoom lens is analyzed for a different set of optical aberrations.”**

196. 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.

197. Thus, 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.

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

## **8. Claim 18**

**The system of claim 14:**

### **a. Element [18A]**

**“wherein the optical aberration is vignetting;”**

199. Niikawa discloses this limitation for the reasons explained above in

[3A].

**b. Element [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”**

200. Niikawa discloses this limitation for the reasons explained above in

[3B].

**c. Element [18C]**

**“wherein the image exposure is optimized to correct the vignetting.”**

201. Niikawa discloses this limitation for the reasons explained above in

[3C].

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

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

203. It is my opinion that claim 4 is obvious over (a) Niikawa in view of Ito. It also is my opinion that claims 4 and 16 are obvious over (b) Niikawa in view of Enomoto and Ito.

**1. Claim 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.”**

204. 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.*, 123; *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.

205. Niikawa does not explicitly disclose using a fast Fourier transform (FFT) algorithm to correct the at least one optical aberration. However, 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. Ito specifically teaches that chromatic aberration can also be corrected by subjecting each color to a fast Fourier transform, instead of using one color as the standard and correcting the focal lengths of the other colors. Ito, ¶17. A POSA would have been motivated to use the FFT of Ito to thus correct chromatic aberrations.

206. A POSA would have also been motivated use a FFT to accurately produce higher quality images. 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, 123.

207. 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).

208. 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.

209. 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).

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

## **2. Claim 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.”**

211. Niikawa in view of Ito and Niikawa in view of Enomoto and Ito render obvious this limitation for the reasons explained in [4].

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

**C. Ground 3**

213. It is my opinion that claims 1-2, 14-15 and 17 are obvious over Matsutani in view of Shiomi.

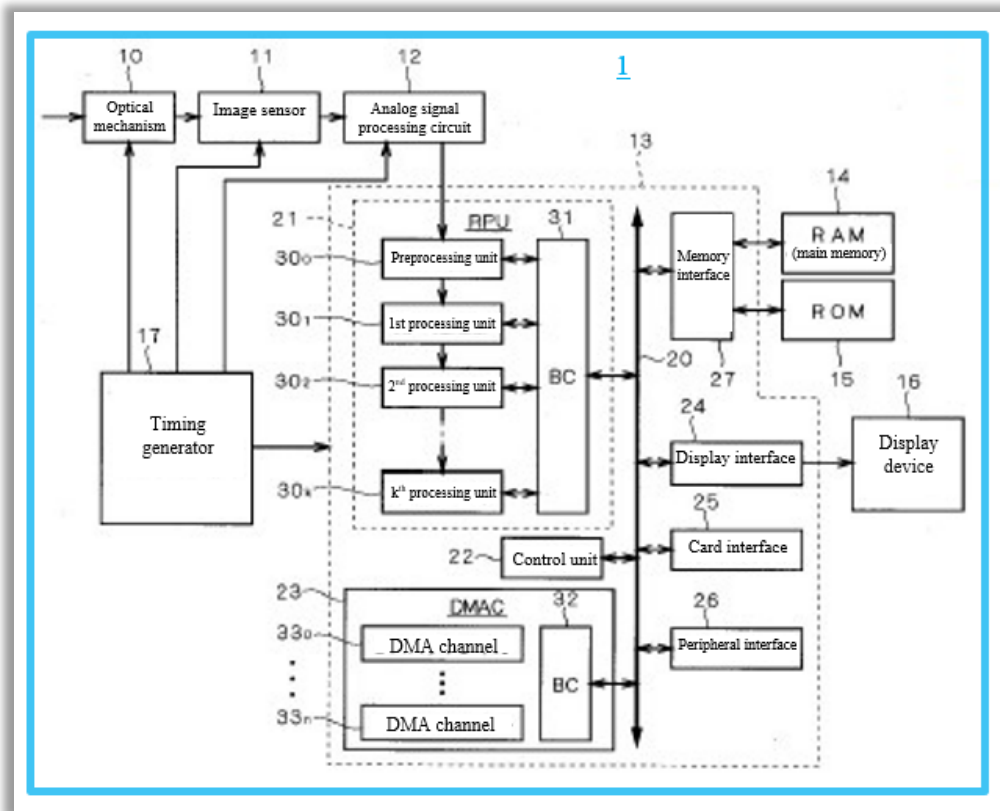
**1. Independent Claim 1**

**a. Element [1Pre]**

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

**b. Element [1A-1]**

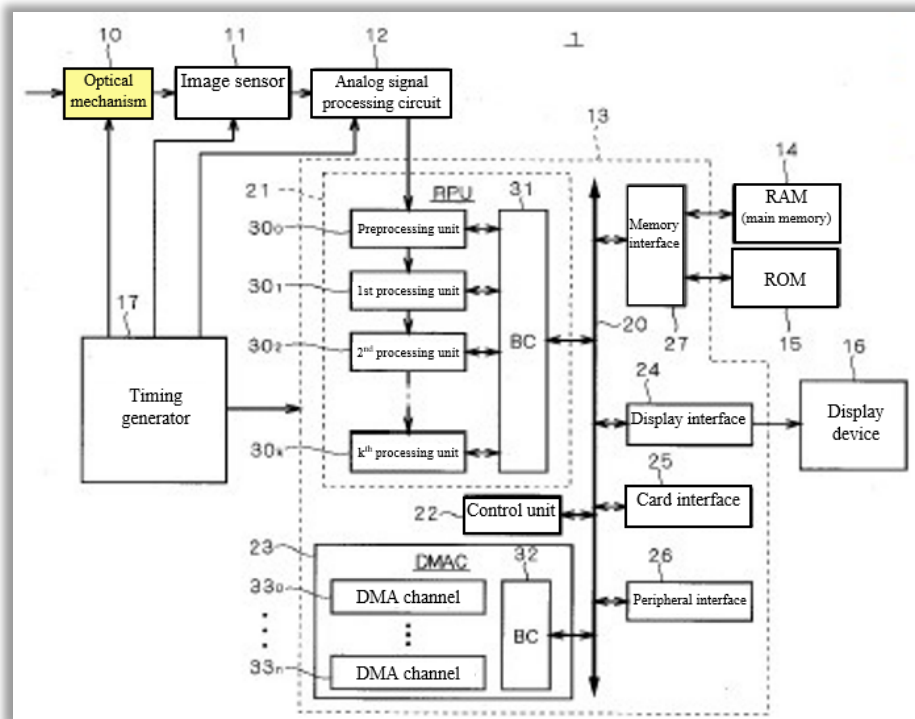
215. Matsutani discloses a digital camera. Ex-1006, [0023], Fig. 1. Digital camera 1 includes components for imaging, processing, and displaying corrected images. *Id.*, [0023]-[0029].



Ex-1006, Fig. 1.

**c. Element [1A-2]**

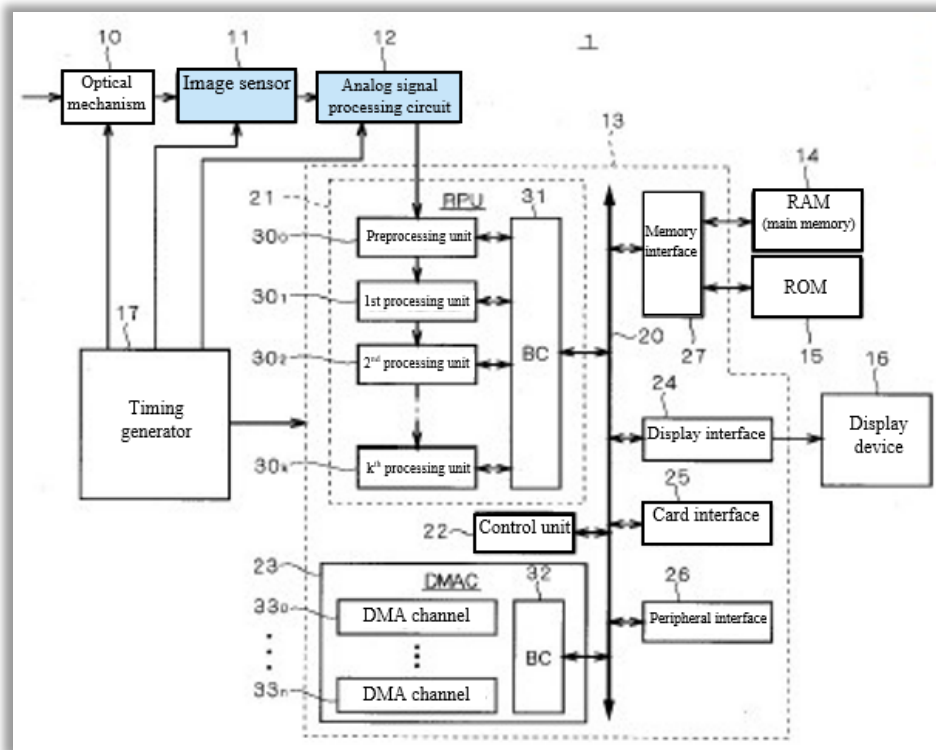
216. Matsutani discloses optical mechanism 10 (yellow) “with an optical lens.” Ex-1006, [0024], Fig. 1.



Ex-1006, Fig. 1.

**d. Element [1A-3]**

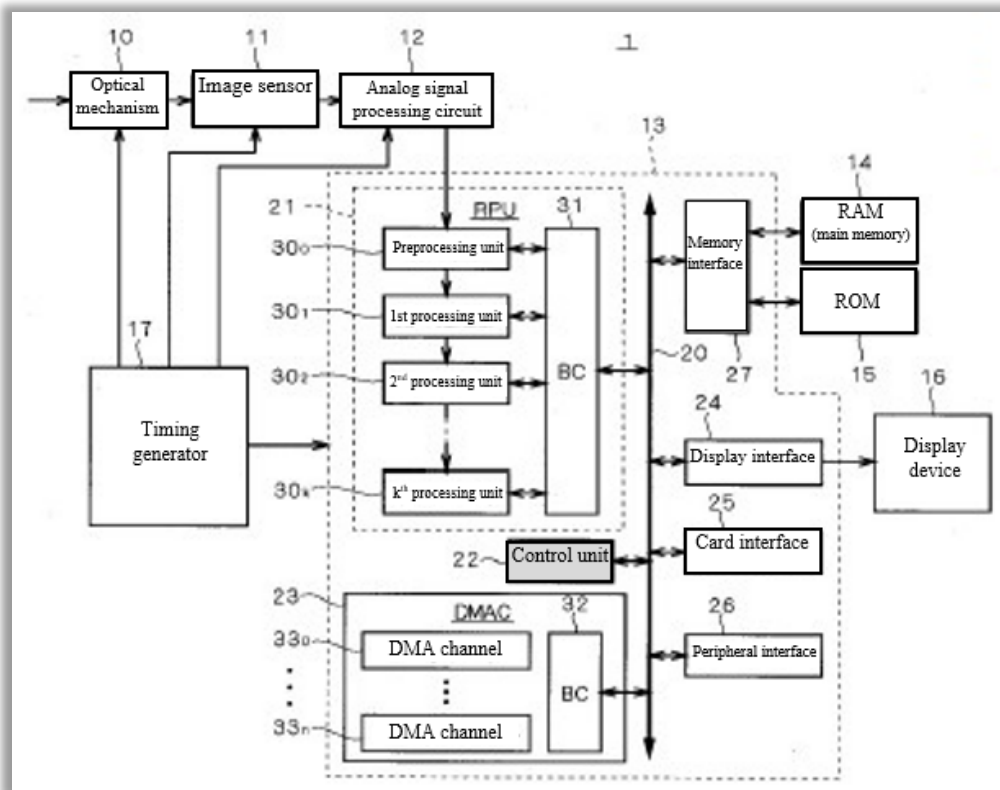
217. Matsutani discloses image sensor 11, which includes a CCD or CMOS sensor for photoelectrically converting light that has passed through the optical mechanism 10, and an analog signal processing circuit 12, which converts analog image signals to digital image signals. Ex-1006, [0023]-[0024], Fig. 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-1006, Fig. 1.

**e. Element [1A-4]**

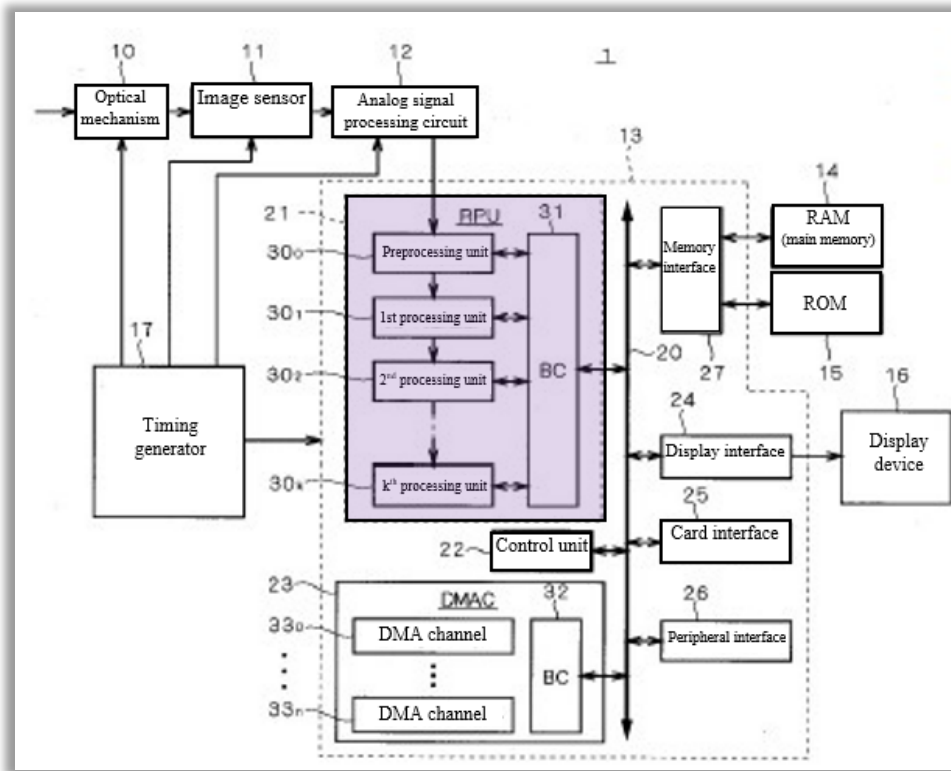
218. Matsutani discloses a CPU included in control unit 22. Control unit 22 has a built-in CPU, and executes a program loaded from ROM 15 to perform control processing for controlling each processing block in real-time processing circuit (“RPU”) 21, as well as image processing, etc. Ex-1006, [0026]-[0027],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



Ex-1006, Fig. 1.

**f. Element [1A-5]**

219. 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 30<sub>2</sub> 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 30<sub>2</sub> in the RPU 21).



Ex-1006, Fig. 1.

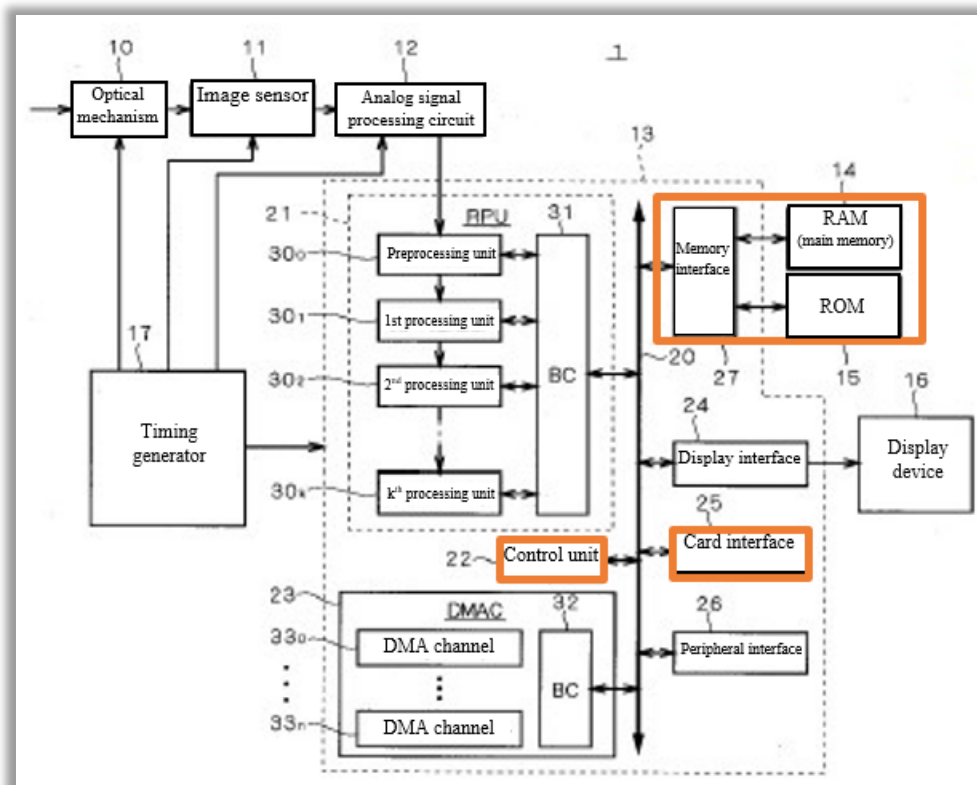
**g. Element [1A-6]**

220. 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-1006, [0027]. The program loaded from ROM 15 is system software.

**h. Element [1A-7]**

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

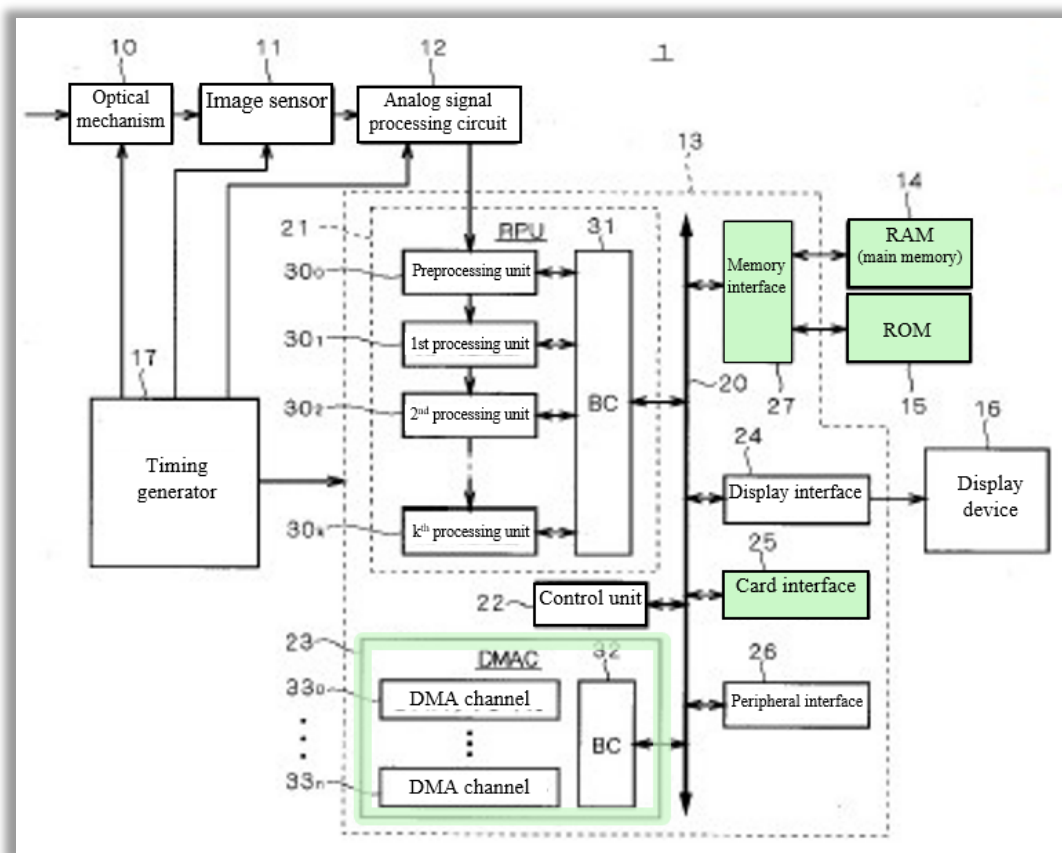
memory access controller (“DMAC”) 23 “reads out, from the main memory 14, coefficient data corresponding to the filter range of  $5 \times 5$  pixels of input data sampled by the convolution calculator 41, and transfers the coefficient data to the RPU 21 by DMA.” *Id.*, [0045]. Figure 6 shows the coefficient data 42 being transferred to the filtering unit  $30_2$  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-1006, Fig. 1.

**i. Element [1A-8]**

222. 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-1006, Fig. 1.

**j. Element [1B]**

223. 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].

224. 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.*

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

**k. Element [1C]**

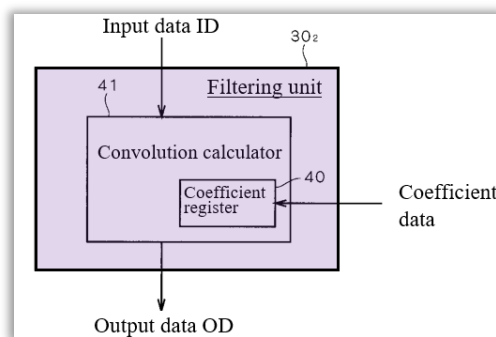
226. Matsutani identifies a wide range aberrations that should be corrected: “the amount of correction must be selected in accordance with changes in imaging conditions.” Ex-1006, [0003]. The CPU (i.e., the microprocessor) “executes a program loaded from the ROM 15 to perform control processing for controlling 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  $5 \times 5$  pixels of input data sampled by the convolution calculator 41, and transfers that coefficient data to RPU 21. *Id.*, [0045].

### I. Element [1D]

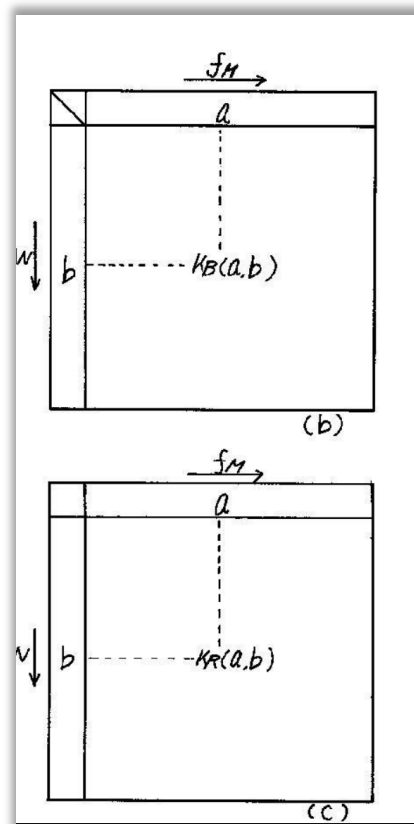
227. As explained in [1C], Matsutani discloses that the CPU (i.e., the microprocessor) selects the amount of correction and contemplates multiple correction techniques pointing to Shiomi and Ito. Ex-1006, [0003], [0027], [0045], Fig. 6.

228. Figure 3 depicts how the convolution calculator 41 of the filtering unit 30<sub>2</sub> (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-1006, Fig. 3.

229. To the extent not expressly disclosed, a POSA would have been motivated to combine the teachings of Shiomi with Matsutani. 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  $\Delta N$  are stored, and the manner in which the aberration correction coefficients are determined from the tables [is] in accordance with  $f_M$  and  $\Delta N$ .”), Figs. 6(a)-(b).



Ex-1011, Fig. 6.

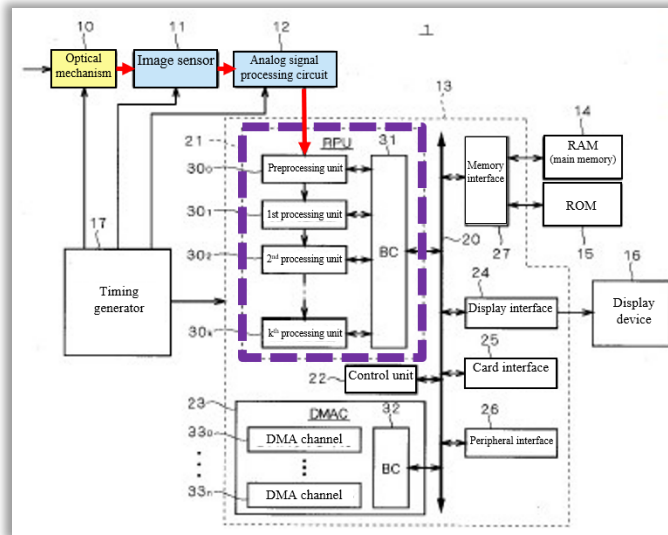
230. Matsutani and Shiomi establish that “various aberrations (chromatic aberration, spherical aberration, coma aberration, astigmatism, field curvature and distortion, etc.) attributable to the optical system” were known. Ex. 1011, [0003], [0005]. Shiomi and Matsutani both disclose using correction 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.*

231. 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.

**m. Element [1E]**

232. 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.

233. 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).



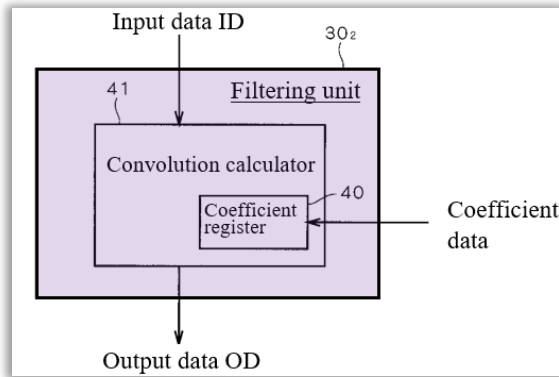
Ex-1006, Fig. 1.

**n. Element [1F]**

234. Matsutani discloses that the filtration unit  $30_2$  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].

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

236. Figure 3 depicts how the convolution calculator 41 of the filtering unit  $30_2$  (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-1006, Fig. 3.

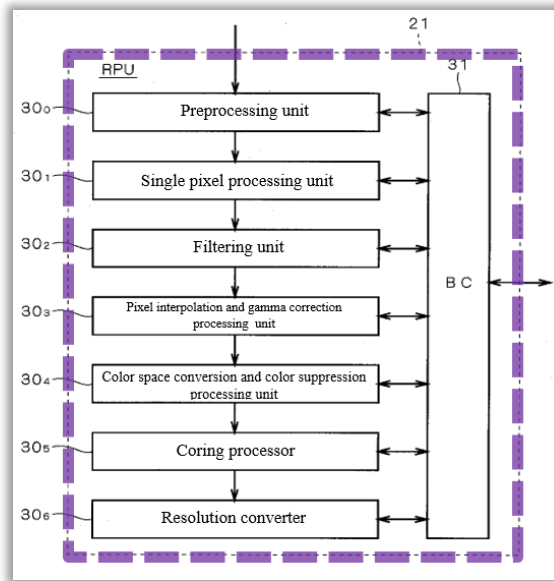
237. Matsutani also discloses that geometric distortion in the image data, such as barrel aberration, may be corrected by “filtering processing” by dynamically updating the filter coefficients stored in the coefficient register 40 of the filtration unit 30<sub>2</sub>. *Id.*, [0048]-[0050], Fig. 7.

238. 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).

#### **o. Element [1G]**

239. Matsutani discloses that after correcting the aberration at the filtering unit 30<sub>2</sub>, RPU 21 may further process the digital image data in at least processing stages 30<sub>3</sub>-30<sub>6</sub>. Ex-1006, [0033], [0036]-[0039], Fig. 2.

240. Figure 2 illustrates a configuration of processing stages 30<sub>3</sub>-30<sub>6</sub> in RPU 21 (purple). *Id.*



Ex-1006, Fig. 2.

241. 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].

242. Accordingly, claim 1 would have been obvious in view of Matsutani in view of Shiomi.

## 2. Claim 2

243. 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).

244. Accordingly, claim 2 would have been obvious in view of Matsutani in view of Shiomi.

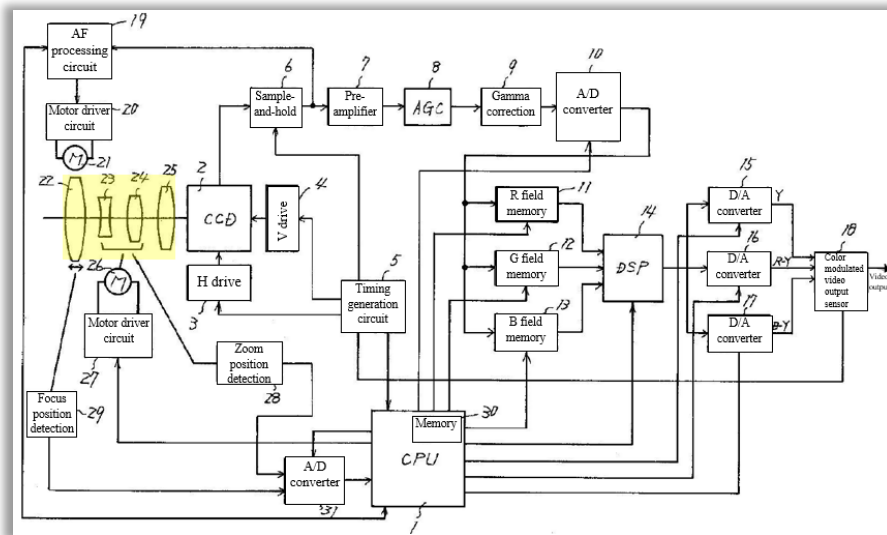
### **3. Independent Claim 14**

#### **a. Elements [14pre]-[14A-8]**

245. *See* [1pre]-[1A-8].

#### **b. Element [14B]**

246. 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-1011, Fig. 1.

**c. Element [14C]**

247. 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].

248. 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].

249. Shiomi discloses wherein the zoom lens changes focal length positions.

**d. Element [14D]**

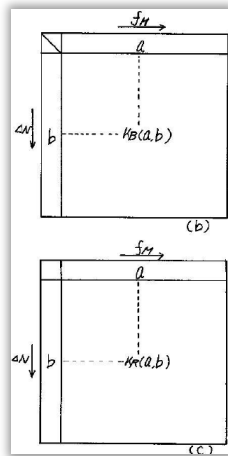
250. See [1E], [1G].

**e. Element [14E]**

251. Matsutani discloses this limitation as explained in [1C].

252. To the extent not expressly disclosed, a POSA would have motivated to combine the teachings of Shiomi with Matsutani.

253. 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  $\Delta N$  are stored...”), Figs. 6(b) and 6(c) (below, showing the arrangement of aberration correction coefficients in a database).



Ex-1011, Fig. 6.

254. 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  $\Delta N$ ) to identify at least one optical aberration in the image file at any focal length of a zoom lens configuration.

**f. Element [14F]**

255. 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].

256. 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].

257. Shiomi discloses that the microprocessor accesses tables (a database) to obtain aberration correction coefficients. Ex-1011, [0021]. A POSA would have understood that the aberration correction coefficients of Shiomi could be applied to the filtration correction algorithm (“Formula 1”) of Matsutani. A POSA would understand the coefficients and related algorithms are or can be stored and accessed to perform the correction.

258. 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).

**g. Element [14G]**

259. 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].

260. 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.

261. 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.

**h. Element [14H]**

262. *See* [1A-8], [1G], [14G].

263. Accordingly, claim 14 would have been obvious in view of Matsutani in view of Shiomi.

**4. Claim 15**

264. *See* [2].

265. Accordingly, claim 15 would have been obvious in view of Matsutani in view of Shiomi

## **5. Claim 17**

266. 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  $\Delta N$  to select specific correction (coefficient) data from the main memory 14. Each focal length corresponds with a different set of aberrations.

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

268. Accordingly, claim 17 would have been obvious in view of Matsutani in view of Shiomi.

## **D. Ground 4**

269. It is my opinion that claims 3, 5 and 18 are obvious over Matsutani in view of Shiomi and Enomoto II.

### **1. Claim 3**

#### **a. Element [3A]**

270. Matsutani discloses that image data captured by an image sensor includes various aberrations and that the single pixel processing unit 30<sub>1</sub> of RPU 21

(DSP) performs “shading correction processing to correct uneven brightness in the image.” Ex-1006, [0003], [0034].

271. 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.

**b. Element [3B]**

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

273. 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.

274. 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. 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).

275. 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).

276. 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.

**c. Element [3C]**

277. 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.

278. Matsutani in view of Enomoto II discloses wherein the image exposure is optimized to correct the vignetting.

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

## **2. Claim 5**

### **a. Element [5A]**

280. Matsutani does not explicitly teach that each lens type is registered in the camera database. However, 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.

281. 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).

282. 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.

**b. Element [5B]**

283. Matsutani does not expressly teach that multiple optical aberrations of each lens is listed in the database. However, 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.

284. 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.

**c. Element [5C]**

285. Matsutani discloses this limitation as explained in [1D] and [5B].

286. 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].

**d. Element [5D]**

287. 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].

**e. Element [5E]**

288. *See* [1G].

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

**3. Claim 18**

**a. Elements [18A]-[18C]**

290. *See* [3A]-[3C].

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

**E. Ground 5**

292. It is my opinion that claims 4 and 16 are obvious over Matsutani in view

of Shiomi and Ito.

**1. Claim 4**

293. 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. Ito discloses that a FFT algorithm can be used to correct chromatic aberration by “digital signal processing.” Ex-1009, [0017]-[0018].

294. 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.

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

**2. Claim 16**

296. *See* [4].

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

**F. Secondary Considerations of Non-Obviousness**

298. I am unaware of any applicable secondary considerations of non-obviousness. None were identified or asserted during prosecution. *See generally* Ex.

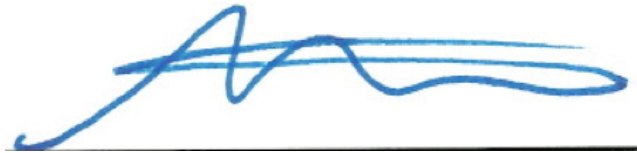
1002. Regardless, even if such considerations existed, none would overcome the strong *prima facie* showing of obviousness.

## **XII. Conclusion**

299. For the reasons set forth above, in my opinion, all limitations of all claims of the '339 Patent are disclosed by the prior art (and combinations thereof) cited herein.

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

Executed on August 30, 2024 in Notre Dame, Indiana.

A handwritten signature in blue ink, appearing to read 'Robert Stevenson', is written over a solid black horizontal line.

Robert Stevenson