

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SONY CORPORATION,
Petitioner,

v.

OPTIMUM IMAGING TECHNOLOGIES, LLC,
Patent Owner.

Case No. IPR2024-00923
Patent No. 10,873,685

**DECLARATION OF LEONARD LAUB
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW**

Sony Exhibit 1003 Sony v. Optimum

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I, Leonard Laub, declare:

I. INTRODUCTION

1. I have been retained by Wolf, Greenfield & Sacks, P.C., on behalf of Sony Corporation (“Sony” or the “Petitioner”) as an independent technical expert in the above-captioned IPR proceeding (“the IPR”). This document provides certain of my opinions concerning the patentability of claims in U.S. Patent No. 10,873,685 (EX1001, “the ’685 patent”), specifically claims 1-19 and 22-30 (the “Challenged Claims”). I make this Declaration in support of Sony’s petition in the IPR.

2. For my work as an expert in this matter, I am being compensated for my services at my standard rate, plus actual expenses. My hourly compensation is based solely on the amount of time that I devote to activity related to this case and is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other personal or financial stake or interest in the outcome of the present proceeding. I do not have any expectation or promise of additional business with the Petitioner in exchange for the positions explained herein.

3. I make this Declaration based on my personal knowledge, including my education, training, research, and professional experience.

II. PERSONAL AND PROFESSIONAL BACKGROUND

4. I am qualified to render expert opinion in this matter by virtue of my professional experience and education, which are summarized below. A copy of my CV detailing my educational background and professional experience is provided with this Declaration as EX1004.

5. I have more than fifty-five years of experience working on optical systems design and analysis with industry as an employee and later as a consultant through my firm Keryston Associates, Inc. I have worked extensively in digital camera system design and image processing since 1965. Throughout this time, I have designed, implemented, and tested various optical imaging systems and products.

6. Some prior work experience most relevant to the issues discussed in this Declaration are summarized below.

7. At Zenith Radio Corp. (1965-1976), I performed work including (1) detailed mathematical and experimental study of lens aberrations and designs to minimize same while developing novel commercial imaging and projection systems for cameras and displays, (2) invention and development of novel electronic image processing systems, and (3) invention and development of real-time Fourier-transform techniques for image analysis and processing.

8. While consulting to Infodetics (1984-1988), I performed work including development of advanced image sensors with embedded real time digital processing.

9. While consulting to Sony and others (2006-2012), I performed work including intensive analysis of techniques and of hardware and software implementations of advanced digital image processing systems incorporating Fourier transform techniques and complex filtration.

10. While consulting to DxO Labs (2007-2018), I performed work including (1) in-depth analysis of digital image processing systems for correcting lens aberrations based on look-up tables of measured aberrations; and (2) support of development of digital image processing systems to produce high-quality images from smartphone cameras using simple lenses.

11. I am a named inventor in 20 patents (U.S. and foreign) concerning electronic video image processing and various complex optical and electro-optical systems.

12. I have been a member of the Optical Society of America (now Optica) for 50 years.

13. I am a Life Member of the Institute of Electrical and Electronic Engineers (IEEE) and an Observer Member of the Advanced Television Systems Committee (ATSC), which maintains standards for digital television in the USA.

14. I received a Bachelor of Science degree in Physics from Illinois Institute of Technology in 1970.

15. I undertook additional graduate level studies including (i) the study of Mathematics at Northeastern Illinois University, 1971-1972 (toward M.Sc.), (ii) the study of Optics at University of Rochester, 1974, and (iii) the study of Physics at Northwestern University, 1974-1975 (toward Ph.D.).

16. My curriculum vitae is provided as EX1004.

III. MATERIALS REVIEWED AND CONSIDERED

17. I have reviewed the '685 patent, its prosecution history, and the prior art and other documents and materials cited herein. For ease of reference, the full list of documents that I have considered is included in Appendix B. I have also considered the documents cited and referenced herein, even if not included in Appendix B. Each of these materials is a type of document that experts in my field would have reasonably relied upon when forming their opinions and would have had access to either through the applicable patent office and/or well-known libraries, conferences, publications, organizations, and websites in the field as further discussed herein.

18. My opinions in this Declaration are based on my review of these documents, as well as upon my education, training, research, knowledge, and experience. When developing the opinions set forth in this declaration, I assumed

the perspective of a person having ordinary skill in the art (a “POSA”), as set forth below.

19. The opinions and comments formulated during this assessment are based on observations and information available at the time of this investigation.

IV. MY UNDERSTANDING OF PATENT LAW

20. In developing my opinions, I discussed various relevant legal principles with Petitioner’s attorneys. I have relied upon such legal principles, as explained to me, while forming the opinions set forth in this declaration. My understanding in this respect is as follows:

21. I understand that “*inter partes* review” (IPR) is a proceeding before the United States Patent & Trademark Office for evaluating the patentability of an issued patent’s claims based on prior-art patents and printed publications.

22. I understand that, in this proceeding, Petitioner has the burden of proving that the challenged claims of the ’685 patent are unpatentable by a preponderance of the evidence. I understand that a “preponderance of the evidence” means that the evidence establishes that a fact or conclusion is more likely true than not true.

23. I understand that patent claims can be independent or dependent. I understand that a dependent claim must reference a claim previously set forth, and then must specify a further limitation of the claimed subject matter. I also

understand that a dependent claim is treated as incorporating by reference all limitations of the previously recited claim that it references. I understand that an independent claim does not reference or incorporate limitations from a previously disclosed claim.

24. I understand that, in IPR proceedings, claim terms in a patent are given their ordinary and customary meaning as understood by a person of ordinary skill in the art (“POSA”) in the context of the entire patent and the prosecution history pertaining to the patent. If the specification provides a special definition for a claim term that differs from the meaning the term would otherwise possess, the specification’s special definition takes precedence. I have applied these standards in preparing the opinions in this declaration.

25. I understand that for an invention claimed in a patent to be patentable, it must be, among other things, new (and consequently not anticipated) and not obvious from the prior art. My understanding of these two legal standards is set forth below.

A. Anticipation

26. I understand that, for a patent claim to be “anticipated” by the prior art (and therefore not novel), each and every claim limitation must be disclosed, expressly or inherently, in the subject matter provided by a single prior-art reference. I understand that anticipation requires that all of the elements of a claim

have to be arranged in the same manner as in the claims or can be immediately envisaged. I understand that a claim limitation is disclosed for the purpose of anticipation if a POSA would have understood the reference to disclose the limitation based on inferences that a POSA would reasonably be expected to draw from the explicit teachings in the reference when read in the context provided by the POSA's knowledge and experience.

27. I understand that a claim limitation is inherent in a prior art reference if that limitation is necessarily present when practicing the teachings of the reference, regardless of whether a POSA recognized the presence of that limitation in the prior art.

B. Obviousness

28. I understand that a patent claim may be unpatentable if the claimed invention would have been obvious to a POSA in view of a single prior-art reference or a combination of prior-art references. I have been informed that obviousness is determined from the perspective of a hypothetical person of ordinary skill in the art and that the asserted claims of the patent should be read from the point of view of such a person at the time the alleged invention was made. I have been informed that a hypothetical person of ordinary skill in the art is assumed to know and to have all relevant prior art in the field of endeavor covered by the '685 patent and would thus have been familiar with each of the references

cited herein, as well as the background knowledge discussed in the art and the full range of teachings they contain.

29. I have been informed that there are two criteria for determining whether prior art is analogous and thus can be considered prior art: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the patentee's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the patentee is involved. I have also been informed that the field of endeavor of a patent is not limited to the specific point of novelty, the narrowest possible conception of the field, or the particular focus within a given field. I have also been informed that a reference is reasonably pertinent if, even though it may be in a different field from that of the patentee's endeavor, it is one which, because of the matter with which it deals, logically would have commended itself to a patentee's attention in considering his problem.

30. I understand that a patent claim is obvious if the differences between the subject matter of the claim and the prior art are such that the claimed subject matter, as a whole, would have been obvious to a POSA at the time the invention was made. I have been informed as well that a prior art reference should be viewed as a whole. Specifically, I understand that the obviousness question involves a consideration of the scope and content of the prior art; the differences between the

prior art and the claims at issue; the knowledge of a POSA; and any “secondary considerations” of non-obviousness.

31. I have been informed that certain factors called “secondary considerations” can include (1) the invention’s commercial success, (2) long felt but unresolved needs, (3) the failure of others, (4) skepticism by experts, (5) praise by others, (6) teaching away by others, (7) recognition of a problem, (8) copying of the invention by competitors, and (9) other relevant factors. I have been informed, however, that for such objective evidence to be relevant to the obviousness of a claim, there must be a causal relationship (called a “nexus”) between the claim and the evidence and that this nexus must be based on what is claimed and novel in the claim rather than something in the prior art. I also have been informed that even when they are present, secondary considerations may be unable to overcome primary evidence of obviousness (e.g., motivation to combine with predictable results) that is sufficiently strong.

32. I am not aware of any such “secondary considerations” applicable to the Challenged Claims. To my knowledge, the Patent Owner has not asserted any such secondary considerations with respect to the ’685 patent. However, should any be presented, I may address those unknown factors if asked by the Petitioner to do so.

33. I understand that for a claimed invention to be considered obvious, a POSA must have had a reason for combining teachings from multiple prior-art references (or for altering a single prior-art reference, in the case of obviousness in view of a single reference) in the fashion proposed.

34. I have also been informed that in considering whether an invention for a claimed combination would have been obvious, I may assess whether the POSA would have had reasons to combine known elements in the prior art in the manner claimed in view of interrelated teachings of multiple prior art references, the effects of demands known to the design community or present in the marketplace, and/or the background knowledge possessed by a person having ordinary skill in the art. I have been informed that other principles may be relied on in evaluating whether an alleged invention would have been obvious, and that these principles include the following:

35. A combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.

36. When a device or technology is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or in a different one, so that if a person of ordinary skill in the art can implement a predictable variation, the variation is likely obvious.

37. If a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

38. An explicit or implicit teaching, suggestion, or motivation to combine two prior art references to form the claimed combination may demonstrate obviousness, but proof of obviousness does not depend on, or require, showing a teaching, suggestion, or motivation to combine.

39. Market demand, rather than scientific literature, can drive design trends and may show obviousness.

40. In determining whether the subject matter of a patent claim would have been obvious, neither the particular motivation nor the avowed purpose of the named inventor controls.

41. One of the ways in which a patent's subject can be proved obvious is by noting that there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent's claims.

42. Any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

43. “Common sense” teaches that familiar items may have obvious uses beyond their primary purposes, and in many cases a person of ordinary skill in the art will be able to fit the teachings of multiple patents together like pieces of a puzzle.

44. A person of ordinary skill in the art is also a person of ordinary creativity and is not an automaton.

45. A patent claim can be proved obvious by showing that the claimed combination of elements was “obvious to try,” particularly when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions such that a person of ordinary skill in the art would have had good reason to pursue the known options within his or her technical grasp.

46. And one should be cautious of using hindsight in evaluating whether an alleged invention would have been obvious.

47. I understand that a POSA must have a reasonable expectation of success in combining the teachings in the references that underly a combination. I understand that a reasonable expectation of success refers to the likelihood of success in combining the teachings in references to meet the limitations of the claimed invention, e.g., to achieve the claimed invention. I understand that in evaluating a combination, a predictable result means not only that the prior art

elements are capable of being physically combined, but also that the combination would have worked for its intended purpose.

48. I have been asked to consider the patentability of the Challenged Claims. I have been informed that for *inter partes* reviews (“IPR”), unpatentability must be shown under a preponderance of the evidence standard. I have been informed that to establish something by a preponderance of the evidence one needs to prove it is more likely true than not true. I have concluded that the Challenged Claims are unpatentable at least as obvious based on the references described below and as explained herein.

V. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

49. I have been informed and understand that for purposes of assessing whether prior-art references disclose every element of a patent claim (thus “anticipating” the claim) and/or would have rendered the claim obvious, the patent and the prior-art references must be assessed from the perspective of a person having ordinary skill in the art (“POSA”) to which the patent is related on the patent claim’s date of invention. I have been informed and understand that a POSA is presumed to be aware of all pertinent prior art and the conventional wisdom in the art, and is a person of ordinary creativity. I have applied this standard throughout my declaration.

50. I understand that the '685 patent issued from an application filed on July 6, 2007. I also understand that the '685 patent purports to claim priority to a provisional application filed on July 11, 2006. However, I have been asked to assume that the Patent Owner has a burden to prove on a claim-by-claim basis that any particular claim is entitled to a priority date or date of invention of July 11, 2006. I understand that at the time of this declaration the Patent Owner has not made any such showing. If the Patent Owner attempts to make such a showing, I understand that I may be asked to respond in a subsequent declaration. Accordingly, I have been asked to assume that the time of invention for each claim in the '685 patent is July 6, 2007, and I have applied that understanding in forming my opinions throughout this Declaration.

51. In my opinion the '685 patent concerns the fields of digital imaging systems and image processing, particularly digital signal processing. The relevant fields include understanding the imaging properties of physical optics, specifically the optical distortions or aberrations introduced by imaging systems, as well as other artifacts introduced to digital images by imaging system components.

52. I have been asked to provide my opinions as to the state of the art in these fields on July 6, 2007. Whenever I offer an opinion in this declaration about the knowledge of a POSA, the manner in which a POSA would have understood the claims of the '685 patent or its description, the manner in which a POSA would

have understood the prior art, or what a POSA would have been led to do based on the prior art, I am referencing the July 6, 2007 timeframe, even if I do not say so specifically in each case.

53. I was asked to identify the POSA and their ordinary level of skill in the relevant art on the effective filing date of July 6, 2007. I understand that the POSA's level of skill in the art can be determined by several non-exhaustive factors including (1) the inventor's educational level; (2) the type of problems encountered in the art; (3) prior art solutions to the type of problems encountered in the art; (4) the rapidity with which innovations are made in the art; (5) the sophistication of the technology; and (6) the educational level of active workers in the field. I understand that the prior art discussed in this Declaration is itself evidence for determining the POSA's ordinary level of skill. I have considered these factors in forming an opinion on the POSA's level of skill on July 6, 2007.

54. I believe a POSA in the field of the '685 patent on or around July 6, 2007, would have been a person with a Bachelor of Science degree in electrical engineering or a related field (which includes physics in the case of digital cameras) with at least two years of industry experience or research, both concerning digital camera system design and image processing.

55. This POSA definition is consistent with:

- the practice and experience at the relevant time of integrating effective and affordable hardware and software for improving image quality into digital cameras;
- the considerable literature available at the relevant time teaching logical, mathematical, and electronic ways to do the same;
- the rapid progress at the relevant time in digital camera image resolution (sometimes understood as the number of pixels defining an image capture, often denoted in units of 1 million pixels or “megapixels”) and video frame rates, and in the computing power, signal processor capabilities, and the practicality of integrating these functions onto a single chip; and
- my experience with, at the relevant time, more than 35 years working on digital imaging systems and digital signal processing in the industry.

56. My opinion on the POSA’s background and ordinary skill does not change if I were to consider the definition of a POSA on or around July 11, 2006, although the earlier date would change the scope of the POSA’s background knowledge by limiting it to subject matter that would have been known to practitioners on July 11, 2006, rather than July 6, 2007.

57. By July 2006, I had a B.Sc. degree in Physics, with graduate work in Physics toward a Ph.D. degree and had worked in the consumer electronics and optics industries for more than 40 years. As such, I was qualified as at least a POSA, and I have had a sufficient level of knowledge, experience, and education to provide expert opinions in the field of the '685 patent, particularly on how a POSA would have viewed the prior art. I have worked on projects in the relevant field with a number of professionals who would have qualified as a POSA on July 6, 2007.

58. My opinions below are based on the perspective of a POSA on July 6, 2007. My opinions would not change if I used the perspective of a POSA on July 11, 2006.

VI. CLAIM INTERPRETATION

59. For the purpose of this declaration, I interpret certain claim terms as discussed below:

A. “uses... software to identify at least one optical image aberration”

60. All claims recite a version of an integrated circuit that “uses... software to identify at least one optical image aberration,” for example:

“wherein the integrated circuit uses the in-camera software to identify at least one optical image aberration” ([1.c]);

“wherein at least one optical aberration in at least two frames of the digital video are identified using the in-camera software and the integrated circuit” ([6.d]);

“wherein the integrated circuit uses system software to access the database to identify at least one optical aberration in at least one frame of the video at any focal length of a zoom lens configuration” ([14.e]).

61. The '685 patent's specification states:

“In the process, the camera **identifies a specific lens and refers to a database that matches the lens type with the specific aberrations.** The aberrations are consistent throughout all images for each formula of a specific prime lens type and are thus corrected by adjusting for each specific aberration category.” (EX1001, 10:60-65; emphasis supplied);

“the present system allows each lens type to be digitally corrected for these types of aberrations. The in-camera digital process works by **identifying a specific lens and comparing the lens pattern to an internal database.**” (EX1001, 11:6-10; emphasis supplied);

“Once detection of the lens type, the sensor type, the exposure settings, the user and the subject is made, **optical and digital distortions are identified** and specific combinations of corrections are applied both before and after the digital sensor in order to optimize the image.” (EX1001, 25:18-22; emphasis supplied);

“The digital corrective process is described in FIG. 5. After a **specific lens type is identified (500) and a database is referenced (510), the**

lens type is matched with the specific optical aberrations (520).

The digital filter then applies a correction to specific optical aberrations (530).” (EX1001, 32:21-25; emphasis supplied).

62. I read this as disclosing identifying aberrations by looking up the predetermined aberration characteristics of the lens and lens settings used to capture an image. This approach to identifying aberrations does not include examination of any actual image; rather, it acknowledges that a known lens and lens settings will cause certain aberrations that will be the same in any image captured with that lens and those settings, so those aberrations can then be corrected just using the predetermined aberration characteristics of the lens at those settings.

B. “vignetting”

63. Claims 3, 13, 15, and 19 recite “vignetting.” I am informed by Petitioner’s counsel that in prior litigation the district court construed “vignetting” in U.S. Patent No. 8,451,339, which I understand issued from the parent to the application for the ’685 patent, as “an effect in which the edges of an image are darker than the image’s center.” EX1027, 9-10. This construction is consistent with the ’685 specification. EX1001, 32:5-6 (“In vignetting, the lens (300) makes the edges of the image significantly darker as the light falls off[.]”). It is also consistent with common usage in the subject art.

64. The '685 specification states: “vignetting, a type of aberration[.]”
EX1001, 10:4.

65. All other terms should be given their ordinary meaning to a POSA.

VII. SUMMARY OF OPINIONS

66. I was asked to provide my opinion on (1) the level of ordinary skill in the art pertinent to the '685 patent; (2) the scope and content of the prior art identified below; and (3) the differences between the identified prior art and the Challenged Claims (claims 1-19 and 22-30) in the '685 patent.

67. I was also asked to provide my opinion on reasons a POSA would have combined prior art teachings as explained in various circumstances below, and whether POSAs would have had a reasonable expectation of success in the combinations.

68. In forming my opinions I relied on the materials cited, the teachings in the prior art, my training and experience, and the perspective of the POSA on July 6, 2007. My opinions do not change if I instead assume the level of ordinary skill of the POSA on July 11, 2006.

69. Based on the materials that I have reviewed, the analysis I have performed, and the positions I have summarized within this report, I have formed at least the following opinions listed below.

- Claims 1-2, 5-7, 11-12, 14-15, 17, 27, and 29 are obvious over U.S. Patent Pub. No. 2005/0280877 (EX1005, “Watanabe”).
- Claims 3, 13, and 19 are obvious over Watanabe in view of Japanese Unexamined Patent Application Publication 2004-343358 (EX1007, “Kishida”).
- Claims 4, 8, 9, and 16 are obvious over Watanabe in view of Japanese Unexamined Patent Application Publication 2004-328506 (EX1008, “Kita”).
- Claims 10, 18, 28, and 30 are obvious over Watanabe in view of U.S. Patent Pub. No. 2003/0223007 (EX1009, “Takane”).
- Claims 22, 23, and 25 are obvious over Watanabe in view of Japanese Unexamined Patent Application Publication 06-319106 (EX1010, “Hisamatsu”).
- Claim 24 is obvious over Watanabe in view of U.S. Patent 7,626,632 (EX1011, “Turner”).
- Claim 26 is obvious over Watanabe in view of U.S. Patent 8,559,743 (EX1012, “Liege”).
- Claims 1-2, 6-7, 10, 12, 14-15, 17-18, 27-28 and 30 are obvious over Takane in view of Watanabe.

VIII. THE '685 PATENT

A. Background

70. The '685 patent relates to digital image processing. It describes correcting aberrations that appear in images, which are due, at least, to the lens system of the digital camera used in capture.

1. Aberration Correction

71. Photography is based on using a lens to project an image of a scene onto a surface that can respond to the light in that image. Historically, that surface has been a plate or a flexible film covered with a light-sensitive emulsion containing silver halide crystals (“film”).

72. More recently, cameras have come to use semiconductor photosensor arrays (“sensors”) in place of film. Such a sensor produces electrical signals representing the pattern of light projected onto the sensor by the lens (the original image).

73. Typically, those electrical signals are converted in the camera to digital data representing the image, hence the term “digital photography.”

74. Ideally, the image of the scene projected by the lens would be perfectly sharp, undistorted, and otherwise free of anything or any effect not present in the scene.

75. However, 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.

76. Digital photography brought about new solutions for these problems, as compared to film photography. Digital sensors, microprocessors, and circuits aid in automated and user-assisted correction of image data. This allows for a simpler, smaller, and less expensive lens with greater design flaws to be used where the aberrations caused by such a lens can be corrected in digital processing.

77. While such digital processing was first done in computers working on digitally-represented images collected by cameras, continuing progress in the amount of processing power that can be put in small integrated circuits has come to permit embedding powerful image correction and processing in the software and electronic hardware of a digital camera, even at the level of the cameras built into smartphones.

78. The challenged claims address topics related to digital aberration correction and/or modification of captured image data.

79. In particular, 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. These and other image defects arising due to the construction of the lens are well known to developers and inventors of digital image correction systems. *See* EX1043 at 2:10-14, EX1044 at [0003], EX1045 at 1:32-38, EX1046 at [0012].

80. A digital processing algorithm which carries out image correction is sometimes called a digital filter. *See* EX1046 at [0036]-[0037], [0058], [0066], EX1043 at 4:51-5:13.

81. It has been known since at least 1995 that image correction may be performed in a digital camera using on-board digital processing. *See e.g.* EX1045, 1:9-14, 3:13-16; EX1065, 4:9-26.

82. Digital image correction or filtration can be sufficiently powerful to enable high quality images to be delivered even when the camera uses a smaller, lighter, lower quality lens. *See e.g.* EX1044 at [0003]-[0004].

83. An illustrative example can be seen in a study conducted by Ricoh. EX1047. In that study, image processing was used to correct distortion and shading. EX1047 at p. 103. The test shows the efficacy of these programs, which, as discussed below, were described throughout the prior art. Ricoh tested conditions known to cause certain aberrations such as distortion and peripheral shading. EX1047 at p. 104-105. Ricoh showed that corrections can accurately be made using stored information including characteristics of the lens and the

conditions under which the image was taken. E.g., EX1047, 104 (“distortion aberration depends on the zoom position (the focal length used)”), 105 (“distortion aberration is calculated for each of the conditions of lens zoom position and photographing distance”).

84. Aberrations originate from the design and construction of the lens and are affected by the settings of the lens.

85. Most camera lenses incorporate an aperture (often realized as an iris diaphragm) which can be opened or closed to carrying 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.

86. 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 (see below) to the diameter of the aperture. Larger f-numbers describe smaller aperture settings, which allow less light through the lens to form the image.

87. Changing the f-number by 1.4 (the square root of 2) changes the area of the aperture, and thus the total amount of light sent to the image, by a factor of two. In photographic parlance, this is called a change of “one stop.”

88. The aberrations in the image projected by the lens typically change as the aperture changes. The nature and amount of such changes, and thus the proper corrections for those aberrations, are specific to each lens design.

89. Separately, the aberrations in the image projected by a lens typically change with what can be called the “focusing point,” the distance from the lens at which a subject is rendered in sharp focus in the image. The nature and amount of such changes, and thus the proper corrections for those aberrations, are also specific to each lens design.

90. The scale of the image projected by the lens is determined by the “focal length” of the lens. A larger focal length lens produces a bigger image of a subject at a given distance, and so subjects in the scene are rendered bigger in the image.

91. Some camera lenses permit the focal length to be changed to vary the scale of the image. This changing, typically directed by the user, is often called “zooming” and a lens whose focal length is variable is often called a “zoom lens.”

92. The aberrations in the image projected by a zoom lens typically also change as the focal length changes. The nature and amount of such changes, and thus the proper corrections for those aberrations, are specific to each lens design, as explained in EX1048 (“Goosey”), 1:37-42 (“the requirement to produce a compact zoom lens with a minimum number of independently movable zooming lens units

and a minimum number of lens elements often conflicts with the requirement to produce high quality images over a large focal length range.”), 1:51-57 (“If the optical power of the lens units increases (without additional lens elements) in order to provide a larger zoom ratio, lens surfaces become stronger, compromising the performance of the zoom lens. In addition, the shorter the focal length of the zoom lens in the wide angle mode, the more difficult it is to control field aberrations such as coma, astigmatism and field curvature.”); EX1045, 7:27-32; Kita, claim 10; EX1051, [0007] (“the lens information is aperture data related to the position and diameter of multiple pupils optically formed in the imaging lens, and the correcting unit calculates the light intensity distribution reaching the imaging plane through the multiple pupils based on the aperture data, and corrects the luminance distribution of the image data in a direction to eliminate the light intensity distribution”); EX1044 at [0014]-[0015].

93. Some other camera lenses do not permit the focal length to vary. Such a lens can be called a “fixed focal length lens.” This can permit either a design with lower aberrations than a zoom lens (in the case of what are called “prime” lenses) or a simpler, lighter, and less expensive lens.

94. Digital image correction or filtration must thus either take note of or adapt to the aberrations produced by the lens in use (more sophisticated cameras

permit interchange of lenses for various purposes) at the aperture and, if it's a zoom lens, focal length used to take a particular picture.

95. It was known before the filing date that lens-caused aberrations could be digitally corrected in the camera by storing correction information for each lens and some likely combinations of aperture and (if a zoom lens) focal length settings. *See, e.g.* Watanabe, [0047] (storing aberration correction data corresponding to the type of lens and the focal length settings), *see also* EX1051 at [0032]; Kita at [0060] (selecting a filter by referencing a table that is determined in advance using the zoom value (“zooming amount”), the defocusing amount, and the iris value (“diaphragming amount”) as keys); EX1046 at [0164] (obtaining optical characteristics of an optical system as the image from storage); EX1050 at 4:50-5:4; EX1063 at [0084], [0130] [0168]; *see also id.* [0108], [0123] (describing that correction tables are stored for parameters such as focal length).

96. 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, e.g.* EX1052, [0005]; EX1063, [0083]-[0085], Watanabe, [0046]-[0047].

97. Regardless of where the correction/aberration information was stored in the camera body, the lens, or elsewhere, the available references would make clear to a POSA what information was to be used in processing, where that information could be stored, and how it could be used to correct for aberrations.

2. Digital Video Cameras

98. Digital photographic technique, as described above, captures images and renders them digitally for processing, storage, and delivery. A camera which captures a single image when requested by its user can be called a “still camera.” If this capture is done digitally, the device can be called a “digital still camera.”

99. Motion picture photography is based on collecting a rapid sequence of images. These images are referred to as “frames.” When these images are captured electronically, the result can be called “video.”

100. Digital video cameras work by capturing frames in rapid sequence, with each frame captured as in still digital photography. This is recognized in the ’685 patent: “video be viewed as merely a very rapid (30 to 60 frames per second) application of still photography” (EX1001, 27:37-38).

101. When images are captured and subsequently presented at rates of 24 frames per second (most movies), 30 frames per second (older television and computer monitors), or higher (e.g., 60 frames per second for 1080p 60 high-definition television, 120+ frames per second for gaming monitors), a human viewer perceives an illusion of continuous motion.

102. Video recording was a well-known digital camera functionality in 2006. EX1040 (“Labaziewicz”), 1:14-15 (“[M]ost digital cameras use a zoom lens and a single color image sensor to capture still and motion images.”); EX1041

(“Misawa”), 1:54-2:14 (“digital electronic camera” captures “still and movie images” in “still picture” and “movie picture” modes).

103. Some digital video cameras (e.g., television cameras) are dedicated to video, while others (e.g., many consumer and professional cameras) can take still photos as well as videos. In either case, a digital camera taking video can be called a “digital video camera.”

3. Fast Fourier Transforms

104. The Fourier transform is a mathematical tool which, when applied to an image, presents a map of regions of specific fineness of structure (“spatial frequency”) in that image. This is a useful tool for certain kinds of image analysis and adjustment.

105. The Fourier transform has been known for nearly two centuries, growing out of Jean-Baptiste Joseph Fourier’s 1822 publication. Fourier transforms can be performed digitally on computers, and their mathematical complexity was greatly reduced, permitting simple computers to perform complex Fourier transforms quickly, with the invention by Cooley and Tukey in 1965 of the Fast Fourier Transform (“FFT”). EX1054 (“Russ”), at pp. 277, 315-316; EX1053 (“Gonzalez”) at pp. 208-213.

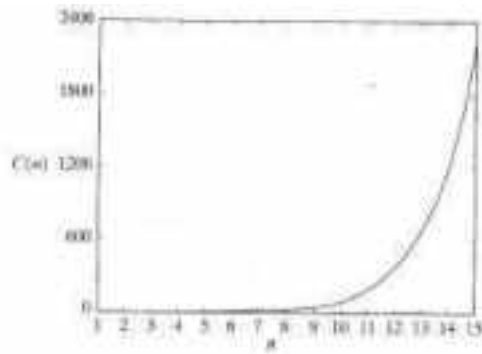


FIGURE 4.42. Computational advantage of the FFT over a direct implementation of the 1-D DFT. Note that the advantage increases rapidly as a function of n .

Gonzalez at p.213.

106. Image processing with Fourier transforms has an extensive literature prior to the filing date. *See, e.g.,* Russ, at pp. 277-332; Gonzalez, at p. 158 (“Filtering in the frequency domain is straightforward.”), 213 (“Virtually all comprehensive signal and image processing software packages have generalized implementations of the FFT.”).

107. As illustrated below, the basic approach to image processing with Fourier transforms uses the practical digital implementations of the Fourier transform, called the fast Fourier transform (“FFT”) or the inverse fast Fourier transform (“IFFT”), in this fashion:

- Perform a Fourier transform (typically by FFT) on the image;
- Apply a filter function which selectively affects different spatial frequencies; and
- Perform an inverse Fourier transform (typically by IFFT) to recover the image, now modified by the filter function.

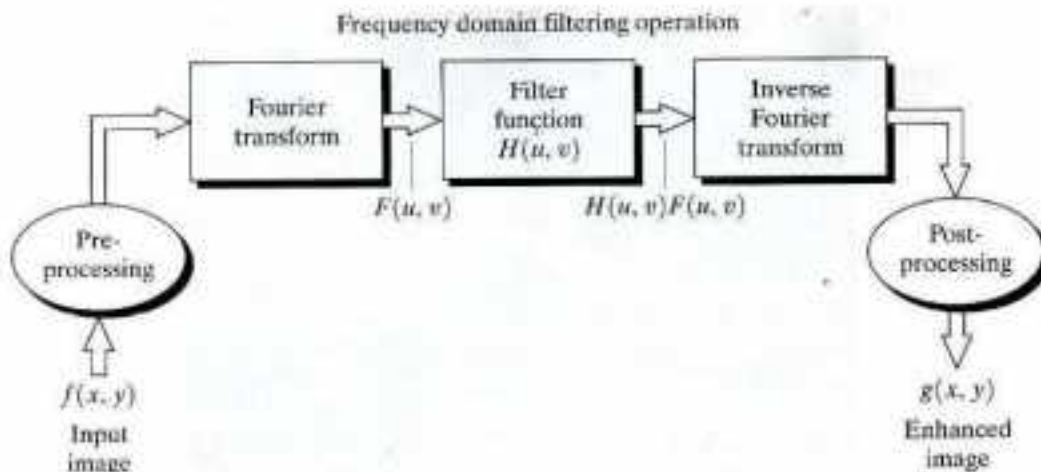
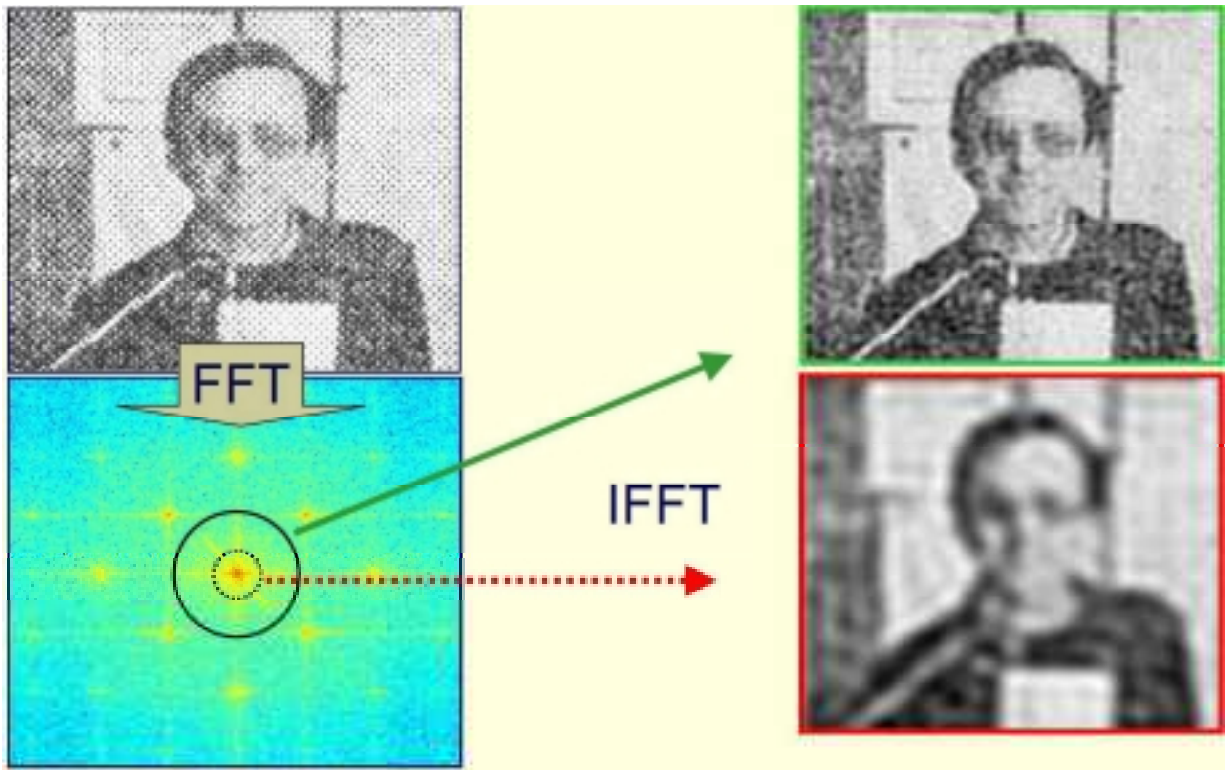


FIGURE 4.5 Basic steps for filtering in the frequency domain.

Gonzalez at p. 159.

108. The illustration below shows two types of FFT, including a filter function and Inverse FFT processing of an image. First, there is noise reduction by excluding in the FFT of the image just the spatial frequencies (cluster of bright dots) carrying the halftone pattern in the original image (the filter function is shown as the larger circle). Second, there is a softening by also excluding some of the spatial frequencies carrying fine detail in the original image (the smaller circle):



EX1076, 42.

109. Fourier transforms, typically FFTs, are known to be useful for sharpening images. *See, e.g.,* Russ at pp. 318-319; EX1064, 5:37-42.

110. Fourier transforms are also used in color adjustment of images. Typically, FFTs are used to convert and suitably filter each individual color component from a captured image into the frequency domain. *See, Ex. 1008* at pp. 308-309. This allows the user to be able to adjust the color hue and saturation, either alone or in conjunction with other processing or effects.

111. The same progress in increased density and power of integrated circuits has permitted FFT-based image processing to be carried out in-camera. *See e.g.,* Gonzalez at pp. 476-477; EX1066 at Abstract, [0009].

4. Camera Components

112. The asserted claims recite many well-known, programmable components. The claims recite a microprocessor, digital signal processor (“DSP”), application specific integrated circuit (“ASIC”), and software. Each of these components was well-known, alone and in combination, and easily programmed to carry out specified tasks. EX1055 at 1:67-2:4 (“Conventional digital image processing, however, utilizes conventional processing technology, such as digital signal processors (‘DSPs’), microprocessors, or application-specific integrated circuits (ASICs).”); *see also* EX1044 at [0005]; EX1056 at [0045]; EX1049 at 4:8-14 (disclosing a microprocessor, DSP, and ASIC); EX1057 at 23:59-64, 24:2 (disclosing a microprocessor, ASIC, and DSP).

113. A POSA would readily appreciate that digital image processing technology for cameras could be implemented in any one of a number of manners. Specifically, a POSA would understand that microprocessors, ASICs, and DSPs can be interchanged and combined as needed to carry out specific functions or processes. Often this is a question of cost and manufacturing efficiencies.

114. The ’685 patent appears to admit this understanding: “This process can be performed with a single microprocessor, multiple microprocessors, multiple ASICs or a combination of microprocessors and ASICs.” (EX1001, 17:64-67).

115. For example, the Challenged Claims recite a microprocessor, a DSP, an ASIC, and software to perform the claimed processing tasks. The '685 patent is vague in its use of the term "DSP." It identifies the DSP as element 195 despite also referring to an ASIC as 195. EX1001, 31:38-41, FIG. 1. The DSP is referred to as element 220 of Fig. 2, despite that portion of Fig. 2 referring to functional steps. EX1001, 32:1, FIG. 2 ("Digital Signal Processing").

116. Software applications for executing image processing were also known before the filing date. EX1049 at 4:8-14; EX1067 at [0047] ("ordinarily be implemented as a software program"). The successful implementation of software-defined processing into cameras was vital to the rise in popularity of digital cameras. Software allows a POSA to program the various internal workings of the camera to carry out the tasks desired by the user.

B. The Claims of the '685 Patent

117. The '685 patent has 30 claims. In this declaration, those claims are parsed as shown in Appendix A.

118. Those parsings are referred to and shown below as limitations are addressed.

IX. GROUND 1: WATANABE RENDERS OBVIOUS CLAIMS 1-2, 5-7, 11-12, 14-15, 17, 27, AND 29

A. Watanabe

119. U.S. Patent Pub. No. 2005/0280877 (EX1005, “Watanabe”) published December 22, 2005 is prior art to all claims of the ’685 patent. Watanabe incorporates JP2004-233872 (EX1006, “JP-872”). Watanabe, [0015].

120. Watanabe discloses in-camera correction for a degradation of light intensity of a peripheral portion (also called “vignetting” as discussed in detail in §VI.B above) and for distortion of a digitally-captured image: “the present invention relates to an image recording apparatus and an image processing system capable of automatically and simply executing an image process such as distortion aberration correction or peripheral light intensity correction.” Watanabe, [0002].

121. Watanabe does so by selecting from among stored correction tables in order find a table that has the necessary information to correct for the distortion aberration and peripheral light intensity caused by the lens at the specific settings of focal length (“zoom position”) and focus distance to subject. Watanabe, [0037]-[0039] (“the digital signal processing circuit 56... executes... correction... The ROM 58 stores programs, data necessary for executing programs, etc.”).

122. Watanabe explains that “tables 70 including distortion aberration correction values and peripheral light intensity correction values in accordance with focusing points and zoom positions are prepared in advance on a lens to lens

basis, then the CPU determines a table according to a lens type and determines correction values according to a focusing point and a zoom position, and image data 72 is obtained in compliance with the correction values.” Watanabe, [0047].

123. Watanabe describes an image processing system for a digital camera that uses a CCD sensor to capture video:

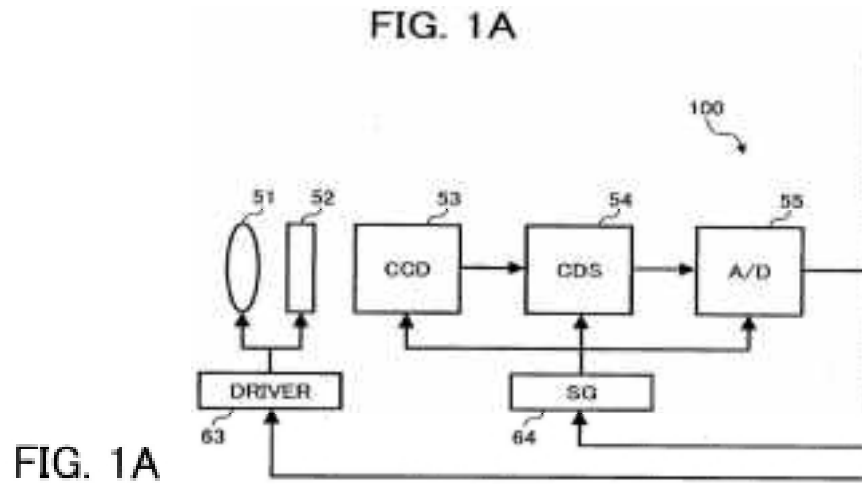
“the digital camera as an image recording device is composed of the following... CCD 53,” JP-872, [0006];

“a digital camera 100 as the image recording apparatus is provided with... a CCD (Charge Coupled Device) 53,” Watanabe, [0035].

124. As shown in Watanabe FIG. 1A, the lens 51 held by its mechanical structure projects an image as a light pattern onto CCD 53. This produces an analog signal representative of each captured image.

125. This signal is then initially processed (CDS 54) and digitized by analog-to-digital (“A/D”) converter 55:

“The CCD 53 is a circuit for converting an image inputted through the lens unit to electrical signals (analogue image data), and the CDS circuit is a circuit for reducing noise for the CCD-type image photographing device. Further, the A/D converter converts analogue image data inputted from the CCD 53 through the CDS circuit 54, to digital image data.” Watanabe, [0037].



126. Watanabe digitizes the video “at an optimum sampling frequency” for “an NTSC signal.” JP-872, [0006]; *see also* Watanabe, [0037]. As discussed below regarding limitation [1.a], an “NTSC signal” is video comprising several images (frames) per second.

127. A “digital signal processing circuit 6... performs various processing” and “correction” to video that has been digitized by A/D converter 5. JP-872, [0006]; *see also* Watanabe, [0038] (“digital signal processing circuit 56... executes various processes” and “correction” to digitized images). Watanabe identifies distortion aberration and peripheral light intensity corrections (JP-872, [0007]; Watanabe, [0047]) and processes the digitized video to apply the corrections (JP-872, [0006]-[0008]; Watanabe, [0032], [0048]-[0064]).

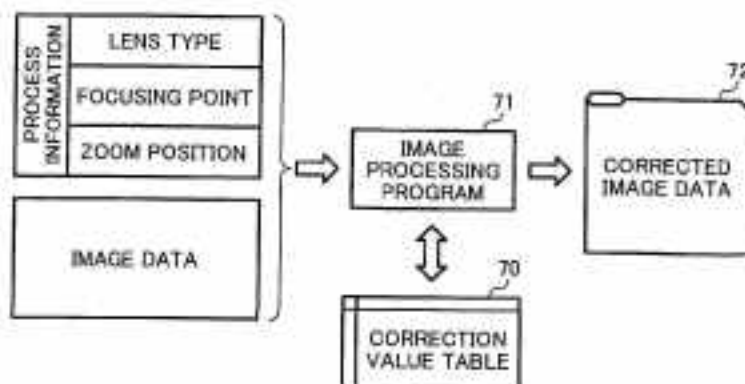
128. As shown below in Watanabe FIG. 3, to each captured image Watanabe adds “information related to lens characteristics” including “lens type...

focal length at the time of shooting... and the zoom position” to the image data (JP-872, [0007]). For example:

- “various data (data 1-data N) are added to image data as process information. As these process information, for example, information relative to lens characteristic (i.e. information relative to distortion aberration in terms of distortion aberration correction), information of peripheral light intensity as information relative to peripheral light intensity correction, and so forth are stored” Watanabe, [0046].

129. This “process information” is produced by the lens and camera. For each captured image, the lens producing that image reports its type and its aperture and focal length settings when the image is captured. The camera receives that information and attaches it to the image data.

FIG. 3



130. The image processing program 71 uses that information to identify and access from the stored table 70 “distortion aberration correction” and

“peripheral light amount corrections” based on “focal length and zoom position for each lens.” JP-872, [0007]; *see also* Watanabe, [0046]-[0047].

131. The image processing program 71 then uses the retrieved stored corrections to produce the corrected image data 72. JP-872, [0007]; Watanabe, [0048].

132. The information in table 70 is collected in advance by the lens or camera manufacturer from design information or measurements of aberrations taken from images a distortion aberration correction process is executed of test targets at various combinations of lens settings:

JP-872, [0007] (“a table 20 of correction values for distortion and peripheral light amount consisting of focal length and zoom position for each lens is prepared in advance”);

Watanabe, [0047] (“tables 70 including distortion aberration correction values and peripheral light intensity correction values in accordance with focusing points and zoom positions are prepared in advance on a lens to lens basis”).

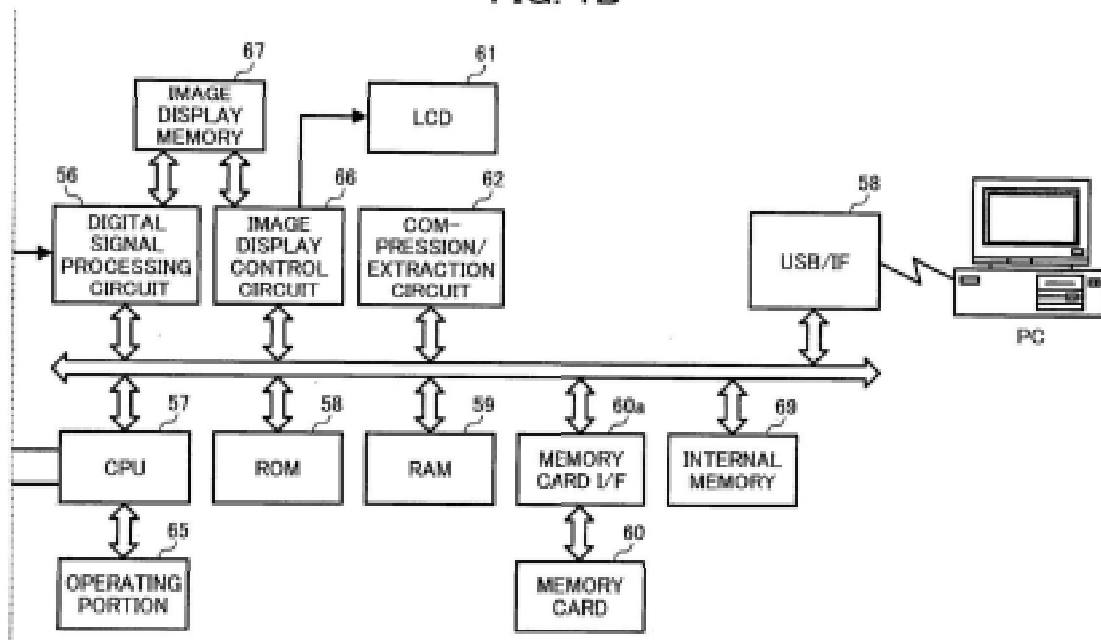
133. Watanabe’s image processing at [0044]-[0064] is capable of correcting aberrations (including peripheral lighting) in both still images and video because digital video comprises a rapid succession of images (frames) as explained in the ’685 patent: “video be viewed as merely a very rapid (30 to 60 frames per second) application of still photography.” EX1001, 27:36-38. Each frame of a

digital video can be aberration corrected by Watanabe in the same manner as each still image.

134. As shown below in a digital camera hardware implementation in Watanabe FIG. 1B, the package of image data and process information (Watanabe, [0046]) enters the digital signal processing circuit 56 (“the digital signal processing circuit 56 sorts out the image data inputted from the A/D converter 55” Watanabe, [0038]). This is connected to a bus, to which the CPU 57, which executes the image processing program 71 (Watanabe, [0042]), and the ROM 58, which contains the control program (Watanabe, [0042]) and the correction value table 70 (Watanabe, [0039]), are also connected. Watanabe, [0035].

135. Watanabe does not limit such a hardware implementation to discrete versus integrated components.

FIG. 1B



B. Claim 1

136. Claim 1 can be parsed into limitations as follows:

#	Limitation
1.PRE	A digital imaging system for correcting optical image aberrations in a digital video, comprising:
1.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing the digital video, an integrated circuit including; a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
1.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
1.c	wherein the integrated circuit uses the in-camera software to identify at least one optical image aberration and
1.d	to correct the at least one optical image aberration in at least one frame of the digital video using at least one of the plurality of optical image aberration corrections in the database;
1.e	wherein the video is captured by the at least one digital sensor and is forwarded to the digital signal processor;
1.f	wherein the video image file with the at least one optical image aberration is corrected by applying digital filtration using the digital signal processor; and
1.g	wherein the corrected video consisting of the digital data optimized from the at least one optical image aberration that are corrected from the original video image is stored in the memory storage sub-system.

137. Watanabe shows the features of claim 1. Many of the claimed elements, e.g., a zoom or fixed focal length lens, digital image sensor, digital signal processor, and memory are well-known and easily implemented hardware components. While Watanabe schematically shows hardware and software meeting the claim, a POSA would have appreciated that any specific hardware or software

arrangement or functionality would be a simple design choice. Watanabe's schematic arrangements in this regard could be adapted or modified without issue.

1. Limitation [1.PRE]

1.PRE	A digital imaging system for correcting optical image aberrations in a digital video, comprising:
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138. If [1.PRE] is limiting, Watanabe meets it because Watanabe describes a digital imaging system:

“an image recording apparatus and an image processing system capable of... distortion aberration correction” (Watanabe, [0002]);

“digital camera 100 as the image recording apparatus is provided with... a digital signal processing circuit” (Watanabe, [0035]).

139. Watanabe corrects optical image aberrations in a digital video as explained above in §IX.A and below regarding limitations [1.a]-[1.g].

2. Limitation [1.a]

1.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing the digital video, an integrated circuit including; a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
-----	--

140. Watanabe meets limitation [1.a] as follows:

a. “digital video camera including in-camera software”

141. Watanabe's “digital camera” (“the digital camera as an image recording device” JP-872, [0006], Fig. 1; “digital camera 100 as the image

recording apparatus” Watanabe, [0035], Figs. 1A-1B) is a “digital video camera” because it captures video with a CCD and digitizes its output:

“The CCD 3 is a circuit that converts the video input through the lens unit into an electrical signal (analog image data), and the CDS circuit 4 is a circuit for reducing noise for the CCD type image sensor. Further, the A/D converter 5 converts analog image data input from the CCD 3 via the CDS circuit 4 into digital image data.” JP-872, [0006].

142. Watanabe’s digital camera also captures video, and so is a digital video camera, because Watanabe describes digitizing video at sampling frequencies optimized for a video signal:

“the output signal of the CCD 3 is converted into a digital signal by the A/D converter 5 via the CDS circuit 4 at an optimal sampling frequency (for example, an integral multiple of the subcarrier frequency of the NTSC signal)” (JP-872, [0006]);

“output signals from the CCD 53 pass through the CDS circuit 54 and are converted by the A/D converter to digital signals at optimum sampling frequency (e.g. an integral multiple of sub-carrier frequency of an NTSC signal)” (Watanabe, [0037]).

143. NTSC is a moving picture video format comprising several images (frames) per second. The term NTSC stands for “National Television Standards Committee.” This was an organization of US television experts convened by the FCC in 1940. In 1953, NTSC issued a standard for a color television (video) signal

carrying 30 (actually 29.97) frames per second (EX1017, I.F.2), where each frame has 525 scan lines (EX1017, I.F.1). In the NTSC standard, color information is carried on a “color subcarrier” of 3.579545 megahertz (EX1017, III.A), from which the scanning frequencies and frame rate are derived (EX1017, I.F.2).

144. By the 1990s it had become common to handle NTSC signals in digital form. The canonical standard 170M by the Society of Motion Picture and Television Engineers (SMPTE) advised operators of analog NTSC studios: “This standard specifies the interface for analog interconnection and serves as the basis for the digital coding necessary for digital interconnection of NTSC equipment.” EX1016, 1.2.

145. SMPTE Standard 244M, originating in 1995, states: “This standard describes a bit-parallel composite video digital interface for systems operating according to the 525-line, 59.94-Hz NTSC standard, as described by SMPTE 170M, sampled at four times color subcarrier frequency.” EX1015, 1.1.

146. The second part of that sentence connects with Watanabe’s disclosure that: “output signals from the CCD 53 pass through the CDS circuit 54 and are converted by the A/D converter to digital signals at optimum sampling frequency (e.g. **an integral multiple of sub-carrier frequency of an NTSC signal**).” Watanabe, [0037] (emphasis supplied).

147. This makes clear Watanabe's "digital camera 100" (Watanabe, [0035] *ff.*) can be a digital video camera, following the SMPTE 244M standard for recording NTSC digital video.

148. Apart from Watanabe's explicit disclosures, digital video cameras were known in which video was captured as a succession of still frames; e.g.:

"digital camera 1 is adapted to be operative in response to a manipulation of an operator to selectively record in optical disk 25 image data representing a still image of an object and consecutive images of the object in the form of movie pictures." EX1041, 2:45-49.

149. A POSA would understand that each such image captured by a digital video camera would need to be corrected in the same manner Watanabe discloses.

150. Watanabe's "control program" can include firmware (code controlling the underlying operations of, directly executed by, and typically stored in the CPU and certain other hardware) as well as higher-level code implementing specific functions such as image processing.

151. Any variation on this would be understood by a POSA to be an example of the claimed "software" in the same way recited by the '685 patent's discussion of embedding "complex system functions including those described herein" into "digital still camera" and "video cameras" as well as "networks of sensors, networks of cameras or integrated networks of both sensors and cameras." (EX1001, 31:50-64).

152. The '685 patent goes on to describe a range of structures and systems in which software would participate in producing corrected images wide enough that a POSA would understand the '685 patent's view of "software" to touch on all seven levels (Physical, Data Link, Network, Transport, Session, Presentation, and Application) of the Open Systems Interconnection ("OSI") stack:

"The digital imaging system applies to consumer and professional still and video camera technologies, to cellular telephones and to personal digital assistants (PDAs)... The present invention also applies to networks of remote camera sensors for surveillance. The system also applies to native digital cinematography and telecine conversion from analogue to digital media. The system may be applied to image scanning and image copying technologies. Finally, the present system may be applied to any optical digital capture, processing and storage sub-system technologies, including groups of sensors or satellites." EX1001, 7:3-17;

"in-camera software can be... remotely downloaded" EX1001, 8:1-5;

"the present system reveals approaches to improve network coordination and wireless external storage and publication capabilities for digital imaging systems." EX1001, 8:33-35;

"The present invention is divided into several main subsystems: (1) digital filters to correct optical and digital aberrations;... (3) digital system improvements that link multiple digital corrections;... and (5) digital image network improvements." EX1001, 8:39-45;

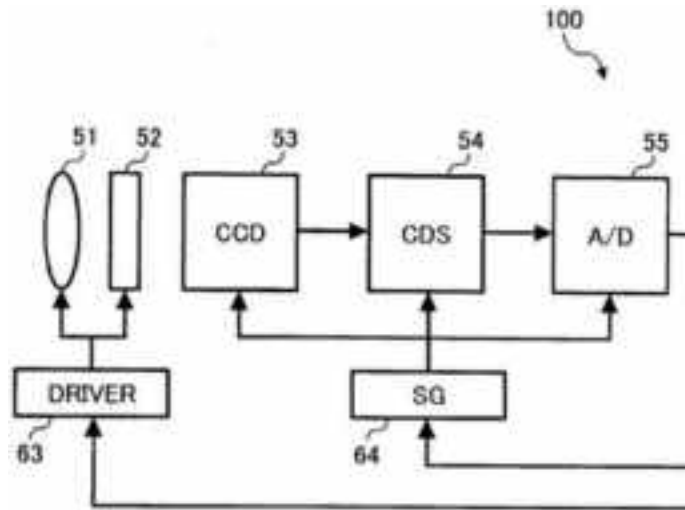
“In order for the camera to learn about the preferences of a specific user, the camera must adjust to each particular user, much as each individual identity must log onto a computer network privately.”

EX1001, 25:12-15.

153. Watanabe’s image recording apparatus discloses “in-camera software” because, as discussed in detail in §IX.A above, it “stores programs” in read-only memory (“ROM”). JP-872, [0006], Fig. 1 (ROM8); Watanabe, [0039] (“ROM 58 stores programs”), [0042] (“control program stored in the ROM 58”), Fig. 1B (ROM 58), Fig. 3 (image processing program 71).

b. “digital sensor for capturing the digital video”

154. The ’685 specification identifies “CCD” as a “digital sensor[]” in which “photons are recorded by electrically charged pixels.” EX1001, 14:17-26. As described in detail in §IX.A above, Watanabe’s CCD captures video, which is digitized. JP-872, [0006] (CCD 3, A/D converter 5), Fig. 1; Watanabe, [0035] (CCD 53, A/D converter 55), [0037] (“A/D converter converts analogue image data... to digital image data”), Fig. 1A.



c. “optical lens mechanism”

155. The term “optical lens mechanism” does not appear in the ’685 patent’s specification, nor does the term “lens mechanism.” The ’685 patent states, “zoom lenses have become extremely complex optical mechanisms consisting of multiple groups of lens elements” (EX1001, 26:1-3) and claim limitation [1.b] imposes the requirement “wherein the optical lens mechanism is a zoom lens of a fixed focal length lens,” so the “optical lens mechanism” of limitation [1.a] is some form of lens.

156. As shown in FIG. 1A and described in detail in §IX.A above, Watanabe discloses lens 51 (Watanabe, [0035]) and states: “A lens unit includes the lens 51, the mechanical structure 52 including the auto focus (AF) mechanism, a diagram [*sic*; should be “diaphragm”] and a filter portion, and so forth.” Watanabe, [0036]. A POSA would have understood that Watanabe’s reference to a “diagram” in [0036] was a typographical error that should read “diaphragm,”

meaning the iris that sets the stops or aperture for the imaging system as used in Watanabe, [0007].

d. “integrated circuit including a digital signal processor”

157. The ’685 patent does not provide, either in the specification or the claims, any description of the claimed “digital signal processor” other than as a name for a body of functional capability assigned to carry out certain processes on digital data. As I understand the ’685 patent, anything which performs the process assigned to the claimed “digital signal processor” can meet this limitation.

158. Semiconductor devices called “digital signal processors” or “DSPs” are general-purpose devices which are directed to carry out a certain process by programming specific to that process.

159. Watanabe’s digital camera includes a central processing unit (“CPU”) and digital signal processing circuit:

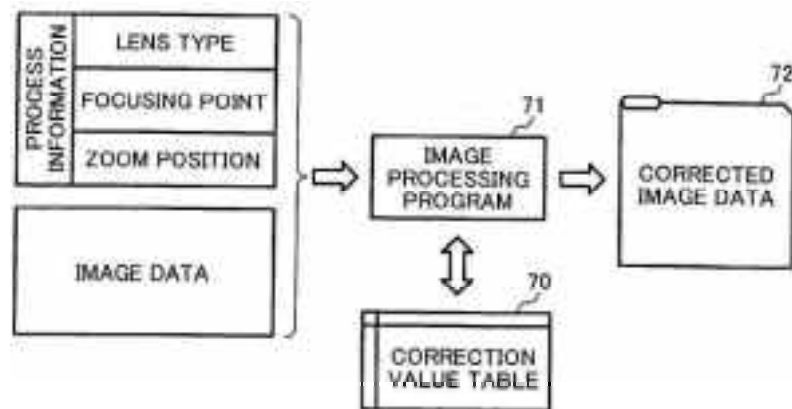
“the digital camera as an image recording device is composed of the following:... digital signal processing circuit 6, CPU 7” JP-872, [0006], Fig. 1;

“The CPU 7, in accordance with the control program stored in the ROM 8... processes image data using the image processing program within the control program.” JP-872, [0007];

“a digital camera 100 as the image recording apparatus is provided with... a digital signal processing circuit 56, a CPU 57,” Watanabe, [0035] Fig. 1B;

“Based on a control program stored in the ROM 58 the CPU 57... processes image data by way of an image processing program in the control program.” Watanabe, [0042].

160. Watanabe meets this “digital signal processor” limitation with the digital signal processing circuit 56 controlled by the CPU 57, which runs the image processing program within operating portion 65 and provides digital signal processing circuit with correction information from the correction value table 70. Watanabe, [0038], [0042], [0047], Figs. 1B, 3.

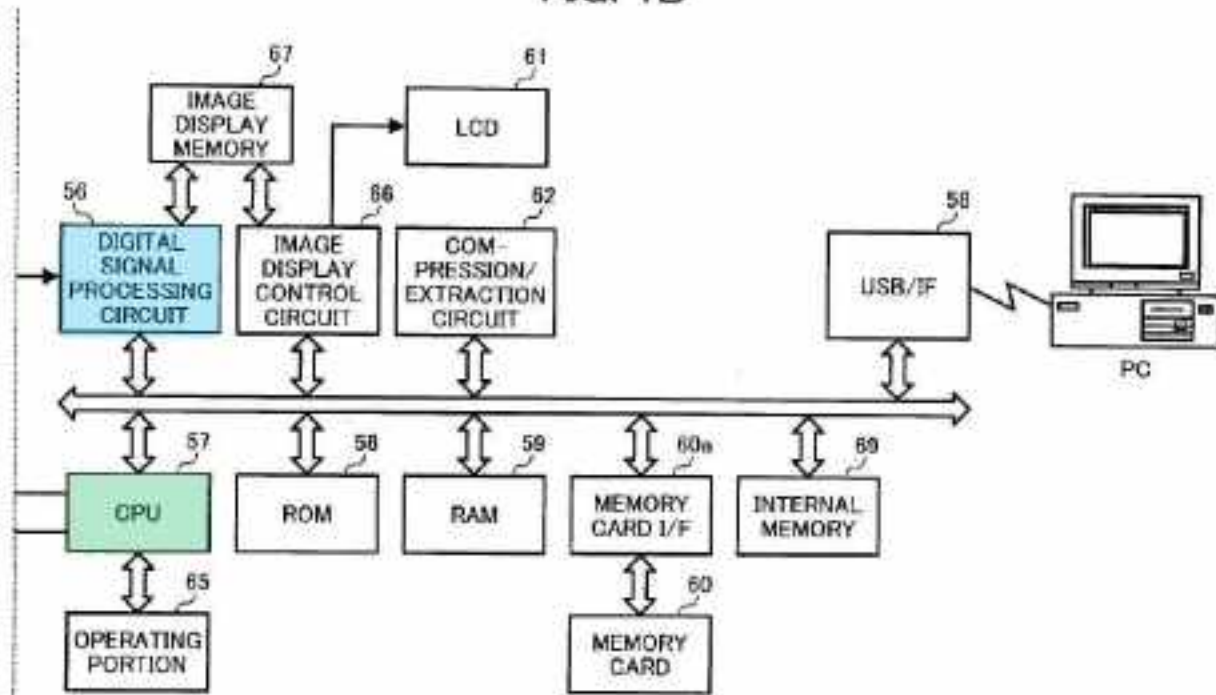


Watanabe, Figure 3.

161. Watanabe’s digital signal processing circuit processes digital signals, and so is a digital signal processor (“DSP”).

162. Watanabe only presents its functional components downstream from the digital sensor, including the digital signal processor and the CPU (highlighted blue and green respectively below) in a schematic way (Watanabe, FIG. 1B):

FIG. 1B



163. Watanabe does not specify how the hardware components of digital camera 100 are implemented, but it was well known, and would have been an obvious and attractive design choice for a POSA, to combine a CPU and one or more DSPs on a single integrated circuit or “chip:”

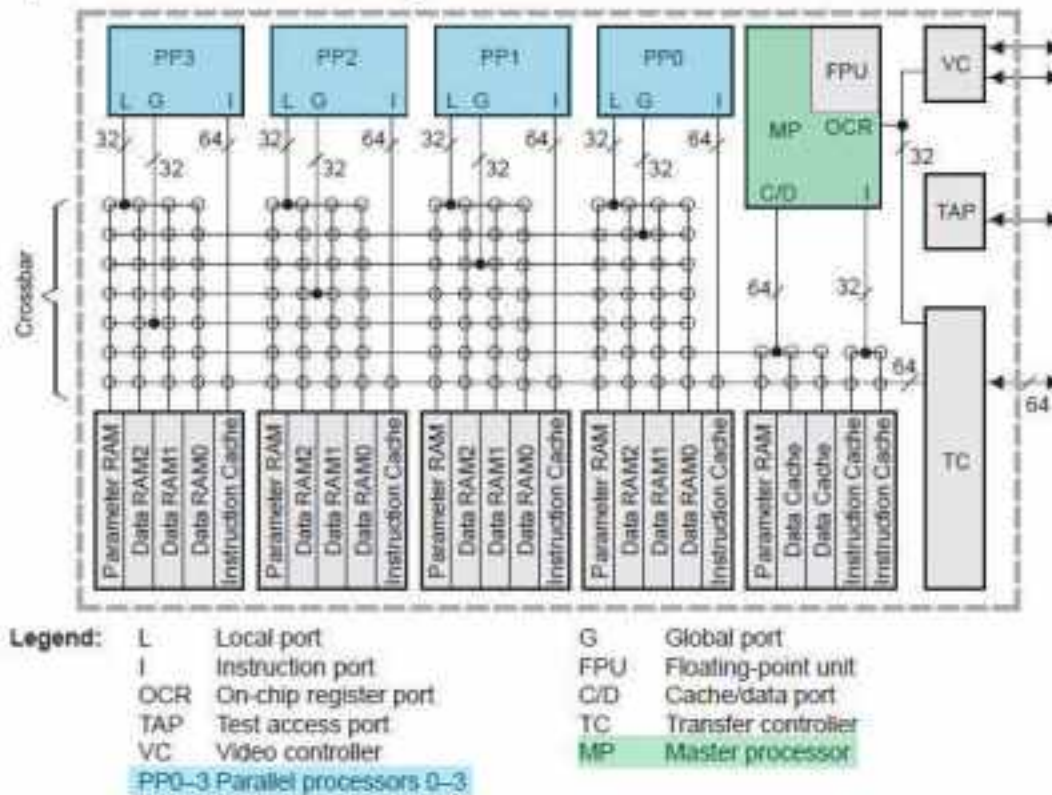
EX1019, SL: 1-1 (“The TMS320C8x digital signal processor (DSP) is a single-chip, multiprocessor device for use in image processing...”);

EX1019, SL: 2-1 (“The TMS320C8x architecture combines RISC processing and the processing power of multiple advanced DSPs (parallel processors).”);

EX1019, SL: 2-3 (“The following information describes each functional unit of the TMS320C8x:

- Master processor (MP). The MP [highlighted green in annotated Figure 2-1 below] is a 32-bit RISC processor with an IEEE-754 floating-point unit (FPU)
- Parallel processors (PPs). The PPs [highlighted blue in annotated Figure 2-1 below] are advanced DSP, 32-bit integer units.”).

Figure 2–1. TMS320C80 Block Diagram



EX1019, Figure 2-1 (annotated).

164. This master processor (MP) is a specific kind of CPU.

165. Computers, both general and special purpose, contain processors (often called “central processing units” or “CPUs”) which can carry out mathematical and logical operations defined in their structures as “instructions” which can be called for by programs provided to and executed by the CPUs.

166. Many dedicated CPUs, as found in digital cameras, need only a modest set of instructions to carry out the kinds of programs they’ll be asked to run. Such processors can be called “RISC” (for “Reduced Instruction Set Computer”) processors because their instruction sets are “reduced” compared to the larger instruction sets of a general purpose processor as found in a Windows or Macintosh computer.

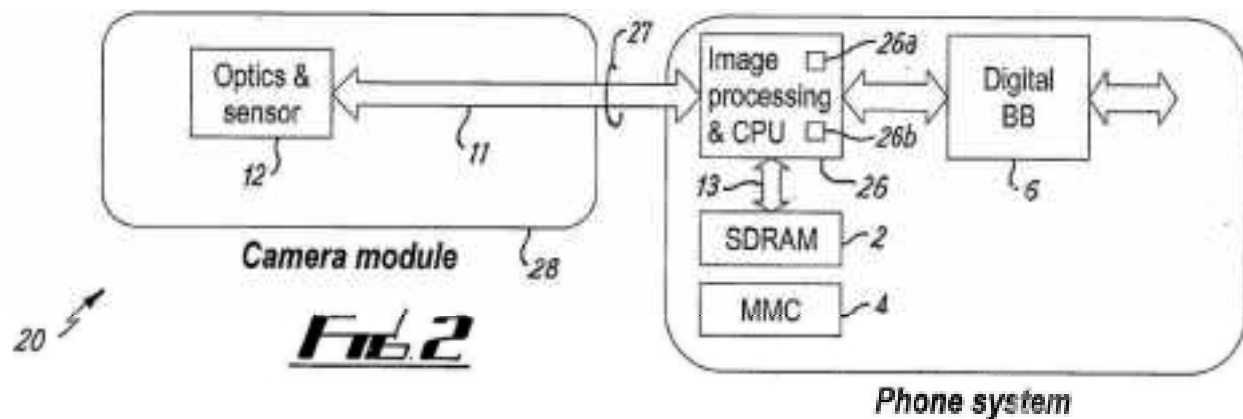
167. A POSA would understand combining a CPU and DSPs suited to the specific application on a chip (making what is sometimes called a “system on chip” or “SoC”) has many practical benefits:

- An SoC is physically smaller and likely less expensive than the equivalent array of discrete components, enabling a more compact and attractively priced product (such as a digital camera for casual users);
- An SoC can permit tasks required by a specific application to be distributed more efficiently or with higher performance than when that application is implemented with discrete components;

- An SoC carries most of the data pathways, so reduces or eliminates the need for traces on a circuit board, further reducing product size, minimizing signal interference and delays, and permitting closer coupling of memory to processes using it;
- An SoC consumes less power than the equivalent array of discrete components, reducing heat and permitting a portable product to have either a smaller battery or longer operating per charge.

168. SoCs were known and available for processing of digital camera images; e.g.:

“Fig. 2 and 3 are schematic illustrations of a mobile camera telephone 20 according to a first embodiment of the invention. The telephone 20 includes, as distinct components, an optics and image sensor 12 and an application processor 26. The application processor 26 is a single chip. It has a CPU block 26a that operates as the CPU of the telephone 20, a camera image processing block 26b that operates as a camera image processor and interfaces 26c to storage devices SDRAM 2 and memory card 4. The application processor 26 may be a system on a chip (SOC).” EX1018, 4:2-9.



169. The considerable and detailed documentation for commercial SoCs and the precedent of SoCs processing images in digital cameras cited above show implementing Watanabe’s image processing with an SoC to achieve some or all of the above-listed benefits to have been within the ordinary skill of a POSA.

170. All these factors would enable a POSA to understand that integrating Watanabe’s CPU and digital signal processor on a single chip provides the claimed “integrated circuit including; [sic] a digital signal processor.” A POSA would have understood that the semicolon after “including” in the ’685 patent claim 1 was a typographical error that reprinted a comma deletion in a claim amendment during prosecution as a semicolon. *See, e.g.*, EX1002, 226. This error does not occur in claims 6 or 14, where the same claim language recurs.

171. Watanabe thus meets [1.a].

e. database management system (“DBMS”)

172. As described in detail in §IX.A above, Watanabe describes “tables 70 including distortion aberration correction values and peripheral light intensity

correction values in accordance with focusing points and zoom positions” that “are prepared in advance on a lens to lens basis[.]” Watanabe, [0047], Fig. 3 (“correction value table 70”). Watanabe’s value “table 20” is also “prepared” to correct distortion aberration and peripheral lighting based on the “focal length and zoom position for each lens[.]” JP-872, [0007].

173. Watanabe’s tables comprise a database as that term would be understood by a POSA:

“a database may be viewed as one or more tables of information”
EX1022 (“Bestgen”), 2:8-12;

“Data records in a computer database are maintained in tables, which are a collection of rows all having the same columns.” EX1023 (“Cesare”), 1:36-39.

174. The term “database management system” does not appear in the specification of the ’685 patent, and only appears in limitation [1.a] as a name.

175. Per EX1029, p. 238, the plain meaning of “database management system (DBMS)” is “software used to create, store, retrieve, change, manipulate, sort, format and print... the information in a database.”

176. A POSA would understand that term to describe something capable of at least finding some specific information in that database in response to a specific query. EX1060 (“Iida”), [0005] (“[A] digital still camera is provided, comprising

search means having a certain compiled database, extracting and bringing up information related to the subject image from the database[.]”).

177. Watanabe discloses “a control program stored in the ROM 58” that CPU 57 uses to “control[] each part” of the camera including “a correction process on image data.” Watanabe, [0042], [0048] (“distortion aberration correction process is executed according to distortion aberration information”), [0059] (“CPU 57... control[s] each part of the apparatus according to the image processing program”), Fig. 4 (step S104 image processing).

178. Watanabe’s “control program” comprises a DBMS because, as described in detail in §IX.A above, it is software that retrieves image correction data associated with lens-specific focusing points and zoom positions from the database (Watanabe’s tables 70, JP-872’s table 20). Watanabe, [0042], [0047], [0049] (“a distortion aberration correction process is executed according to a lens type, a focusing point, and a zoom position”), Fig. 3; JP-872, [0007] (“using the image correction processing program 21, the CPU 7 determines a correction value table based on the lens type, determines a correction value based on the zoom position”).

179. Apart from those specifics, POSAs would have known to use a DBMS to access the correction data in Watanabe’s tables because, as cited above in this section, DBMSs were well known in 2006.

f. “configured to access”

(1) Watanabe’s integrated circuit including a digital signal processor is configured to access a DBMS.

180. The specification of the ’685 patent does not include the term “configured to access.” It does disclose: “The database is accessed to provide the multi-objective optimization solution for correcting several different optical aberrations for each specific lens formula.” EX1001, 32:36-38. However, it does not disclose how that access is carried out. It simply indicates that correction information from the database (“filtration”) has gotten to the DSP: “The DSP applies the filtration (730) to correct the optical aberrations from the lenses.” EX1001, 32:42-43.

181. Watanabe’s DSP is “configured to access” the DBMS because, as described in detail in §IX.A above, Watanabe’s image processing software sends to the DSP image corrections retrieved from the database comprising the correction value table 20 (JP-872, [0007]) or tables 70 (Watanabe, [0047], Fig. 3). JP-872, [0006]; Watanabe, [0038] (DSP circuit 56 “executes various processes” including “correction” to “image data”), [0060]-[0062], Figs. 1A-1B (DSP receives digitized image data under CPU 57 control).

(2) Obvious variations

182. If Watanabe is not understood as disclosing an integrated circuit (“IC”) including a DSP configured to access a DBMS, then POSAs would

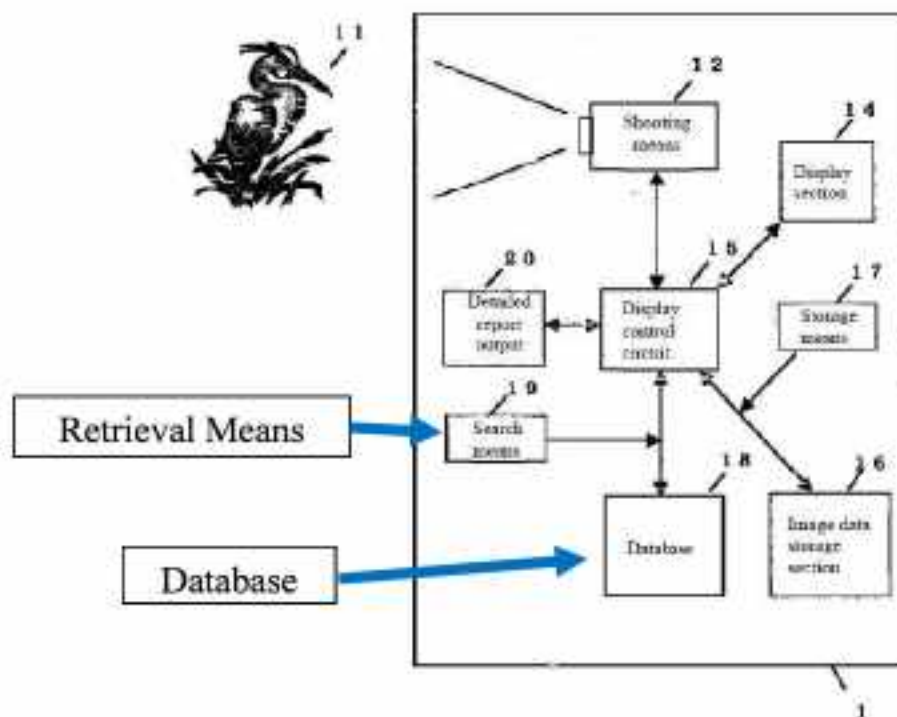
nonetheless have understood that configuring an IC including a DSP to access a DBMS was an obvious variation of Watanabe's disclosure.

183. For example, EX1024, ("Vook") discloses a video camera ([0017]) having a "processor 220" that is capable of "executing an image correction algorithm 260 using image correction data 240" (Vook, [0022]). POSAs would have understood Vook's processor 220 includes a DSP. Vook explains that processor 220 retrieves image correction data 240 from database 230 using key 210. Vook, [0035], claim 1 ("image processor is operable to access said centralized database to retrieve... image correction data").

184. Further, EX1060, (Iida") discloses:

"FIG. 1 is a block diagram of a digital still camera according to the present invention. In the drawing, the digital still camera body 11 according to the first embodiment of the present invention is composed of shooting means 12 having a function of shooting the subject 11 and outputting the image, a display section 14 that displays image data 13 of the subject 11 obtained by shooting with the shooting means 12, a display control circuit 15 that outputs image data 13 for display on the display section 14, an image data storage section 16 that stores image data 13 obtained by shooting, storage means 17 for storing in the image data storage section 16, a certain compiled database 18, a search means 19 for extracting and bringing up related information from the database 18 and information output means 20 for outputting the information." (Iida, [0030]-[0031]);

【Figure 1】



“search means extracting and bringing up related information from a database storing a certain compiled sample image and information related to the sample image” (Iida, [0015]).

185. POSAs would have understood Iida’s “search means” is a database management system that accesses Iida’s “database.”

186. POSAs would have known that they could have implemented Vook’s and Iida’s teachings to have Watanabe’s DSP access a database, meeting [1.a]. Implementing the Vook and Iida teachings in Watanabe with software accessing a database (e.g., a DBMS) was within the POSA’s ordinary skill.

g. “including a plurality of optical image aberration corrections”

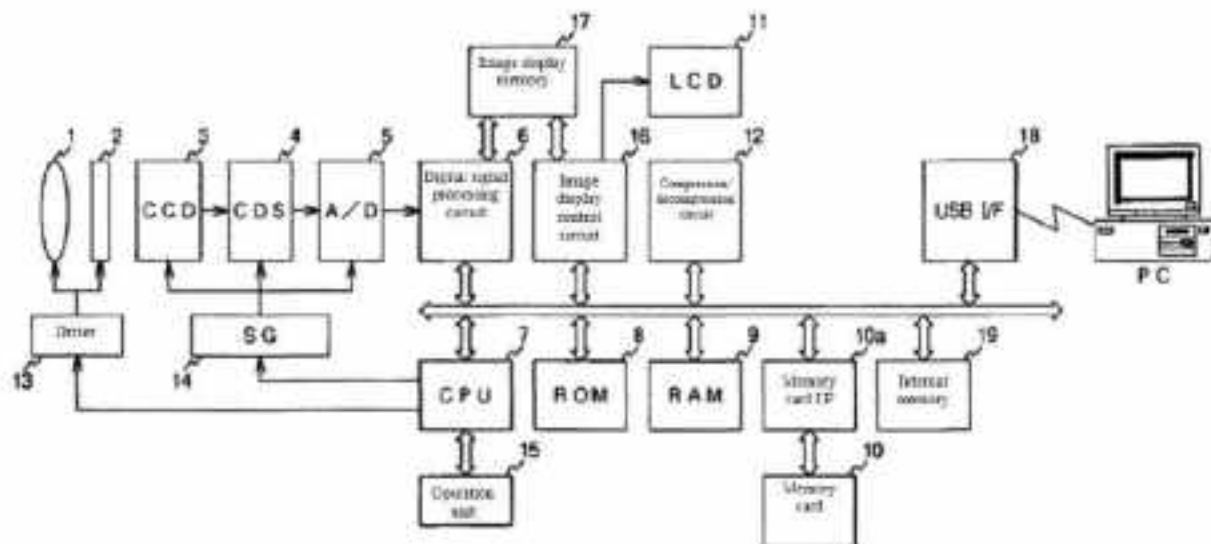
187. Limitation [1.a] recites a DBMS “including a plurality of optical image aberration corrections[.]” Watanabe’s DBMS accesses a database (tables 70 at [0047], table 20 in JP-872, [0007]) that provides distortion aberration and peripheral light intensity corrections for different lenses at different focusing points (i.e., distance from subject to lens) and zoom positions. Watanabe, [0047], [0049]; JP-872, [0007]¹. These are a “plurality of optical image aberration corrections” because the peripheral light correction concerns vignetting, an optical image aberration (per §VI.B above), and because Watanabe describes correcting distortion aberration.

h. memory storage sub-system”

188. Watanabe discloses a “memory storage sub-system.”

189. As shown below in JP-872 FIG. 1, read only memory (“ROM”) 8 “stores programs and data,” random access memory (“RAM”) 9 “temporarily stores data,” and “memory card 10 and built-in memory 19” store image data in “an image data file.” JP-872, [0006]; see also Watanabe, [0035] (ROM 58, RAM 59, memory card 60, memory card interface 60a), [0042] (“control program stored in the ROM 58,” “an image data file recorded in the memory card 60”).

¹ JP-872 uses the term “focal length” in referring to what Watanabe calls “focusing point” and that is how I understand JP-872. JP-872 uses the term “zoom position” in the same way as Watanabe.



3. Limitation [1.b]

1.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
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190. Watanabe describes “zoom position” and correcting distortion “based on... zoom position for each lens.” JP-872, [0007] and refers to a lens having multiple “zoom positions.” Watanabe, [0047], Fig. 3.

191. As described in detail §VIII.A.1 above, the term “zooming” refers to changing the focal length of a lens, and a lens whose focal length is variable is often called a “zoom lens.” Since each lens contemplated by Watanabe has multiple “zoom positions,” Watanabe meets [1.b] because it discloses a zoom lens.

4. Limitations [1.c] and [1.d]

1.c	wherein the integrated circuit uses the in-camera software to identify at least one optical image aberration and
1.d	to correct the at least one optical image aberration in at least one frame of the digital video using at least one of the plurality of optical image aberration corrections in the database;

192. Watanabe meets [1.c] because Watanabe’s in-camera software adds “information relative to distortion aberration” and “peripheral light intensity” (e.g., “at least one optical image aberration”) to image data based on the lens used to capture the image. Watanabe, [0046]; *see also* JP-872, [0007]. Watanabe also includes a CPU running a control program that identifies an optical image aberration correction, and therefore also identifies the optical image aberration, by database lookup based on the lens type, focusing point, and zoom position:

“Based on a control program stored in the ROM 58 the CPU 57... processes image data by way of an image processing program in the control program” (Watanabe, [0042]);

“the CPU determines a table according to a lens type and determines correction values according to a focusing point and a zoom position” (Watanabe, [0047]);

“using the image correction processing program 21, the CPU 7 determines a correction value table based on the lens type, determines a correction value based on the zoom position” (JP-872, [0007]).

193. Watanabe meets [1.d] because the image processing program applies the correction values and corrects the aberration:

“The CPU 7... obtains corrected image data 22 according to the correction value,” JP-872, [0007];

“data results from produced image data on which a distortion aberration correction process is executed according to distortion

aberration information, data results from produced image data on which a peripheral light intensity correction process is executed according to peripheral light intensity information, and so forth can be recorded.” Watanabe, [0048].

194. The ’685 specification states that a “video [can] be viewed as merely a very rapid (30 to 60 frames per second) application of still photography.” EX1001, 27:37-38. Thus, POSAs would have understood that a “frame of the digital video” means a still image, while a video is a sequence of still images played at a frame rate (expressed in frames per second). For example, as described in detail in §IX.B.2.a above, the NTSC video format comprises 525 lines per frame at 29.97 frames per second.

195. As described in detail in §IX.A above, each frame of a digital video can be aberration corrected by Watanabe in the same manner as each still image.

5. Limitation [1.e]

1.e	wherein the video is captured by the at least one digital sensor and is forwarded to the digital signal processor;
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196. As described in detail in §IX.B.2.b above, Watanabe discloses the claimed digital sensor.

197. Watanabe meets [1.e] because Watanabe’s “digital sensor” captures video and forwards it to the DSP. JP-872, Fig. 1, [0006] (“the output signal of the CCD 3 is converted into a digital signal by the A/D converter 5... the digital signal

processing circuit 6 divides the image data input from the A/D converter 5”); Watanabe, Figs. 1A-1B, [0037]-[0038] (“the A/D converter converts analogue image data imputed from the CCD 53 through the CDS circuit 54, to digital image data... the digital signal processing circuit 56 sorts out the image data inputted from the A/D converter 55”), [0061]-[0062] (“the image data are transferred to the image processing program side (Step 203). In the image processing program, the process information and the image data transferred to the image processing program side are received (Step 103)”).

6. Limitation [1.f]

1.f	wherein the video image file with the at least one optical image aberration is corrected by applying digital filtration using the digital signal processor; and
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a. Claim terms

i. “digital filtration”

198. Digital filtering means digital signal processing: EX1028, 193 (“digital filter” is “the computational process or algorithm by which a sampled signal or sequence of numbers (acting as an input) is transformed into a second sequence of numbers termed the output signal.”).

199. The ’685 specification describes digital filtering as “digital filtration”: EX1001, 7:33-35 (“the present system demonstrates that in-camera digital filtration out-performs better than external filters.”);

EX1001 31:65-32:2 (“FIG. 2 describes digital image signal processing. After an analog signal (200) is captured, it is converted to a digital signal by an analog-to-digital converter (210). The signal is then forwarded to the digital signal processor (220) and filtered (230).”). Item 230 in FIG. 2 is labeled “Digital Filtration”:

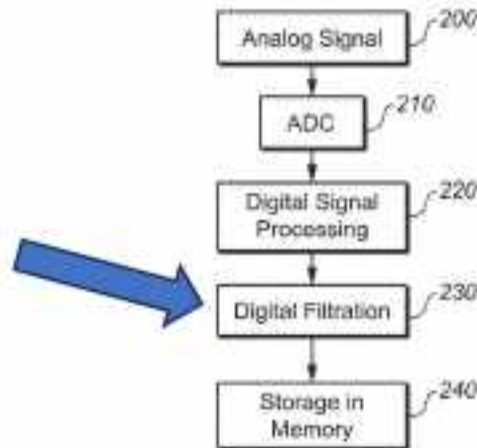


FIG. 2

200. Further, EX1001, 32:42-33:2 (discussing FFT), 32:56-57 (“One example of a digital filtration process is a fast Fourier transform (FFT).”).

201. Watanabe’s digital signal processor’s corrections are “digital filtration” because, per §IX.B.2.f.(1) above, the digital signal processor digitally (numerically) processes the image data to correct it using the corrections from the table:

“digital signal processing circuit 6 divides the image data input from the A/D converter 5 into color difference data and luminance data, and performs various processing, correction, and data processing” JP-872, [0006];

“using the image correction processing program 21, the CPU 7 determines a correction value table based on the lens type, determines a correction value based on the zoom position and focal length, and obtains corrected image data 22 according to the correction value” JP-872, [0008];

See also Watanabe, [0048]-[0049], [0062]-[0063].

ii. “video image file”

202. The term “video image file” has no antecedent basis in claim 1 and does not appear in the specification of the ’685 patent.

203. To the extent “video image file” means the “at least one frame of the digital video” in [1.d], then Watanabe’s DSP corrects it as described below.

b. Watanabe meets [1.f].

204. As described in §IX.B.2.d above, Watanabe discloses the claimed “digital signal processor.” Watanabe meets [1.f] because, as described in detail in §IX.A above, Watanabe’s digital signal processor corrects optical image aberrations in video images (frames, per §IX.B.4 above) by applying corrections from the database:

“the digital signal processing circuit 6... performs... correction,” JP-872, [0006];

“the CPU 7 determines a correction value table based on the lens type, determines a correction value based on the zoom position and focal

length, and obtains corrected image data 22 according to the correction value.” JP-872, [0007];

“The image processing program receives the processing information and image data sent to the image processing program (Step 103), performs image processing on the image data based on the processing information (Step 104),” JP-872, [0008], FIG. 4;

“the digital signal processing circuit 56 sorts out the image data inputted from the A/D converter 55... and executes... correction” Watanabe, [0038];

“the CPU determines a table according to a lens type and determines correction values according to a focusing point and a Zoom position, and image data 72 is obtained in compliance with the correction values,” Watanabe, [0047];

“distortion aberration correction process is executed,” Watanabe, [0049];

“In the image processing program, the process information and the image data transferred to the image processing program side are received (Step 103), an image process is executed on the image data in accordance with the process information (Step 104).” Watanabe, [0062].

205. As the block diagram in Watanabe Figs. 1A-1B suggests, Watanabe’s digital signal processor processes the captured images and corrects distortion aberrations and peripheral light intensity, under CPU control (Watanabe, [0042],

[0059]-[0060]), using the correction data from the database table 70 as shown in Fig. 3 (Watanabe, [0047]).

206. Watanabe discloses the claimed “video image file” by referring to “image data files” (Watanabe, [0039]).

7. Limitation [1.g]

1.g	wherein the corrected video consisting of the digital data optimized from the at least one optical image aberration that are corrected from the original video image is stored in the memory storage sub-system.
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207. Watanabe meets [1.g] because it discloses memory card 10 and memory card interface 10a storing processed image data, e.g., corrected video:

“CPU 7 controls the recording operation of image data on the memory card 10,” JP-872, [0006];

“record data that has been subjected to distortion aberration correction,” JP-872, [0007];

“the processed image data is recorded in a file, that is, the memory card 10 (Step 206),” JP-872, [0008];

Watanabe, Fig. 1B (memory card 60);

Watanabe, Fig. 3 (corrected image data 72);

“data results from produced image data on which a distortion aberration correction process is executed according to distortion aberration information, data results from produced image data on which a peripheral light intensity correction process is executed

according to peripheral light intensity information, and so forth can be recorded,” Watanabe, [0048];

“the image data on which the correction process is executed is transferred to the photographing program and is recorded on the memory card 60,” Watanabe, [0058];

“an image process is executed on the image data in accordance with the process information (Step 104), and the processed image data are transferred to the photographing program side (Step 105)... the processed data transferred to the photographing program side is received (Step 205), and the processed data are recorded on a file, i.e. the memory card 60 (Step 206),” Watanabe, [0062]-[0063].

C. Claim 2

208. Claim 2 can be parsed as follows:

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

209. Watanabe meets [2.PRE] because it meets claim 1 as shown in §IX.B above.

210. Limitation [2.a] recites “optical image aberrations include at least one of” several aberration “types” joined by “and/or.” The “optical image aberrations” has no antecedent basis in claim 1, which recites “optical image aberration” as singular in [1.a], [1.c], [1.d], [1.f], and [1.g], consistent with a single aberration

type from the list in claim 2. I thus understand a single listed “optical image aberration” meets [2.a].

211. Watanabe meets [2.a] because it describes correcting the claimed “lens distortion:”

“distortion aberration correction processing methods include the table lookup method, which calculates the lens distortion rate,” JP-872, [0002];

“perform image processing such as distortion aberration correction,” JP-872, [0003];

“distortion in the case of curvature aberration correction,” JP-872, [0007];

“a table look-up method where a lens distortion aberration rate is predetermined at each focusing point and zoom position,” Watanabe, [0006];

“distortion aberration correction process is executed according to a lens type, a focusing point and a zoom position,” Watanabe, [0049].

D. Claim 5

212. Claim 5 can be parsed as follows:

5.PRE	The system of claim 1:
5.a	wherein each lens type is registered in the camera database;
5.b	wherein the multiple optical aberrations of each lens is listed in the database;
5.c	wherein the filtration solutions to the lens optical aberrations are listed in the database;

5.d	wherein the filtration of each lens optical aberration is applied by the digital signal processor; and
5.e	wherein after the digital signal processor applies the filtration to correct the optical image aberrations the corrected digital file is forwarded to storage in memory.

1. Limitations [5.PRE] and [5.a]

5.PRE	The system of claim 1:
5.a	wherein each lens type is registered in the camera database;

213. Watanabe meets [5.PRE] because it meets claim 1 as shown in §IX.B above.

214. POSAs would have understood that “registered in the camera database” meant that a database associated correction data ([5.c] “filtration solutions”) with “each lens type.”

215. The act of adding information to a database is often called “registering” that information. so that information may be said to be “registered” in that database:

“the portable telephone 11 of a user is registered in a user menu information database (27),” EX1058 (“Takae”), Abstract.

216. As cited in §IX.B.2.e above, “Data records in a computer database are maintained in tables, which are a collection of rows all having the same columns” (EX1023 (“Cesare”), 1:36-39).

217. When retrieving a unit of information (often called a “record”) from a database, the operation can be speeded up if that information can be uniquely

related to a “key” generated when the record is registered, then used in retrieval of that record:

“Relational databases, which store [and] retrieve data from tables having a number of rows and columns, are especially widespread. Key values and indexes are useful features found in most database management systems. Key values are comprised of a single column or multiple columns of a record. Typical key values are account numbers, product codes, and customer names. An index is a structure within the database that can be used to quickly locate data based upon a key value because the key values are ordered. Each key value has at least one record identifier, or pointer, associated with it, which provides access to the entire record in the file. The use of key values and indexes can hasten the processing involved in performing database commands.” EX1059 (“Lee”), 1:26-39.

218. As described in detail in §IX.B.2.e above, Watanabe’s tables 70 (Watanabe, [0047]) and table 20 (JP-872, [0007]) are databases. They meet the “camera database” requirement because they are contained within the camera:

“a digital camera 100... is provided with... a ROM 58,” Watanabe, [0035];

“The ROM 58 stores... data necessary for executing programs,” Watanabe, [0039];

“the digital camera as an image recording device is composed of the following:... ROM 8”), (“ROM 8 stores... data necessary for program execution” JP-872, [0006].

219. Watanabe’s tables 70 (Watanabe, [0047]) and table 20 (JP-872, [0007]) meet the “each lens type is registered” requirement because they are keyed to each lens type:

“if tables 70 including distortion aberration correction values and peripheral light intensity correction values in accordance with focusing points and zoom positions are prepared in advance on a lens to lens basis, then the CPU determines a table according to a lens type,” Watanabe, [0047];

“if... a table 20 of correction values for distortion and peripheral light amount consisting of focal length and zoom position for each lens is prepared in advance, using the image correction processing program 21, the CPU 7 determines a correction value table based on the lens type,” JP-872, [0007].

220. Watanabe meets [5.a] because its tables associate each lens type with correction data for that lens type.

2. Limitation [5.b]

5.b	wherein the multiple optical aberrations of each lens is listed in the database;
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221. Watanabe meets [5.b] because its tables (“the database”) store (and are capable of storing) corrections for curvature aberration, lens distortion, and vignetting (“multiple optical aberrations”) for each lens:

“[T]he processing information stored includes, for example, information related to lens characteristics (that is, information related

to distortion in the case of curvature aberration correction), and information related to peripheral light amount as information related to peripheral light amount correction [A] table 20 of correction values for distortion and peripheral light amount consisting of focal length and zoom position for each lens is prepared in advance[.]” JP-872, [0007];

“information relative to lens characteristic (i.e. information relative to distortion aberration in terms of distortion aberration correction), information of peripheral light intensity as information relative to peripheral light intensity correction, and so forth are stored,” Watanabe, [0046];

“tables 70 including distortion aberration correction values and peripheral light intensity correction values in accordance with focusing points and zoom positions are prepared in advance on a lens to lens basis,” Watanabe, [0047].

3. Limitation [5.c]

5.c	wherein the filtration solutions to the lens optical aberrations are listed in the database;
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222. The term “filtration solution” does not appear in the ’685 specification. However, as described in detail in §IX.B.6.a.i above, the ’685 specification describes digital filtering as “digital filtration” (EX1001, 7:33-37, 31:65-32:2). The ’685 specification also describes “a list of optical distortions that are corrected by in-camera digital solutions” (EX1001, 11:51-52).

223. A POSA would understand the claimed “filtration solutions” are the parameters for the digital filter providing aberration correction claimed in [1.d] and [1.f].

224. Watanabe meets [5.c] because, as described in detail in §IX.D.1 above, Watanabe’s tables (which meet the “the database” requirement) store the corrections (which meet the “filtration solutions” requirement) for the lens optical aberrations.

225. POSAs would also have understood that listing filter solutions to correct lens aberrations was a conventional use of a database for correcting lens optical aberrations:

“a digital still camera is provided, comprising... search means having a certain compiled database, extracting and bringing up information related to the subject image from the database,” EX1060 (“Iida”), [0005];

“The image processing system 200 further includes a centralized database 230 for storing the image correction data 240 for the imaging device 10. The image correction data 240 includes any data designed to compensate for defects in the imaging device 10.” EX1024 (“Vook”), [0023];

“The electronic device 300 further includes the processor 220 for processing the image data 100 and providing the key 210 associated with the imaging device 10 to the database 230 for retrieval of the

image correction data 240 associated with the imaging device 10.”
Vook, [0035];

“To generate high quality images, it is important for the MRI RF receiver to accurately receive and process the weak NMR signals generated by the body. Signal filtering is one of the more important functions performed by the MRI RF receiver” EX1025 (“Hoenninger”), 1:24-28;

“one example provides a parameterized synchronous multi-rate FIR filter that can use up to three filter stages with only the first one needing variable bandwidth and decimation factor. The sets of filter coefficients for the first FIR filter stage are stored in a database (e.g., with up to 512 coefficient entries for each filter.” Hoenninger, 4:11-14.

4. Limitation [5.d]

5.d	wherein the filtration of each lens optical aberration is applied by the digital signal processor; and
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226. Watanabe meets [5.d] because:

- As described in detail in §IX.B.2.d above, Watanabe has the claimed “digital signal processor;”
- As described in detail in §IX.D.3 above, Watanabe’s tables 70 (Watanabe) and table 20 (JP-172) carry the claimed “filtration of each lens optical aberration;” and

- As described in detail in §IX.B.6 above, Watanabe's digital signal processor applies the filtration of each lens optical aberration to an image file.

5. Limitation [5.e]

5.e	wherein after the digital signal processor applies the filtration to correct the optical image aberrations the corrected digital file is forwarded to storage in memory.
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227. Watanabe meets [5.e] for the same reason it meets limitation [1.g].

E. Claim 6

228. Claim 6 can be parsed as follows:

6.PRE	A digital imaging system for correcting image aberrations comprising:
6.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
6.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
6.c	wherein the video is forwarded to storage in memory;
6.d	wherein at least one optical aberration in at least two frames of the digital video are identified using the in-camera software and the integrated circuit;
6.e	wherein the at least one optical aberration from the optical lens mechanism of at least two frames of the digital video are corrected by using the digital signal processor to apply at least one digital filtration algorithm; and
6.f	wherein the corrected digital video file is stored in memory.

1. Limitations [6.PRE], [6.a], [6.b], and [6.f]

6.PRE	A digital imaging system for correcting image aberrations comprising:
6.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
6.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
6.f	wherein the corrected digital video file is stored in memory.

229. Watanabe meets [6.PRE], [6.a], [6.b], and [6.f] for the same reasons

Watanabe meets the corresponding limitations in claim 1:

Limitation	Corresponding Limitation	Detailed Discussion
[6.PRE]	[1.PRE]	§IX.B.1
[6.a]	[1.a]	§IX.B.2
[6.b]	[1.b]	§IX.B.3
[6.f]	[1.g]	§IX.B.7

230. While “corrected video file” in [6.f] has no antecedent basis in claim 6, Watanabe discloses saving corrected video in memory as explained in detail in §IX.B.7 above for limitation [1.g] (JP-872, [0006], [0007], [0008]; Watanabe Figs. 1B, 3, [0048], [0058], [0062]-[0063]).

231. Watanabe was capable of storing corrected video in a file:

“image data are stored in the memory card 60 and the internal memory 69, as image data files.” Watanabe, [0039];

“the processed data are recorded on a file, i.e. the memory card 60 (Step 206)” Watanabe, [0063].

2. Limitation [6.c]

6.c	wherein the video is forwarded to storage in memory;
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232. Watanabe meets [6.c] because Watanabe teaches RAM temporarily stores data to be processed: Watanabe, [0039] (“the RAM 59 temporarily stores data to be processed by the CPU 57”).

233. Watanabe also discloses storing compressed image data, which Watanabe’s system would do even if the image data wasn’t corrected, in a memory card and internal memory:

“Compressed image data is stored in the memory card 10 and built-in memory 19 as an image data file.” JP-872, [0006];

“Compressed image data are stored in the memory card 60 and the internal memory 69, as image data files.” Watanabe, [0039].

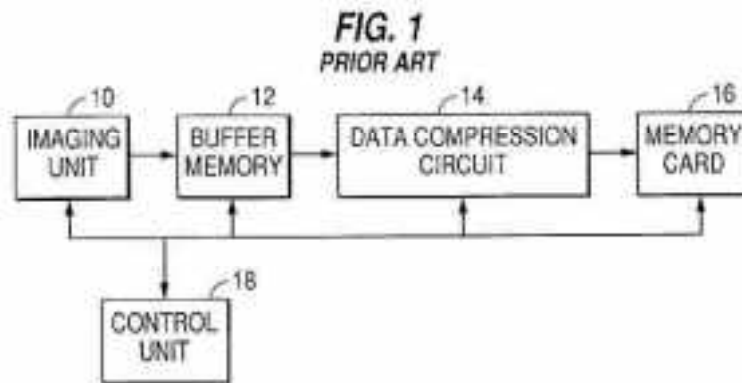
234. Temporary storage (often called “buffering”) of digital image data prior to processing of that image data was well known and would have been understood by POSAs to facilitate “synchronous control of the whole camera” and allow processing to be started when the processor is ready:

“The digital image data is first reversibly compressed by a high speed reversible encoder and temporarily stored in a buffer memory.”

EX1061 (“Juen”), Abstract;

“Still cameras are known which record an image of a photographic subject as a digital image in memory. For example, FIG. 1 is a block

diagram of a prior art imaging system for a still camera which records the image of a photographic subject as a digital image data in memory. An imaging unit 10 photoelectrically converts light from a photographic field by means of a built-in CCD, or similar device, and after white balance correction, amplification, γ correction and the like processing have been performed, the imaging unit 10 performs analog to digital (A/D) conversion and outputs the image as digital image data. A buffer memory 12 temporarily stores the digital image data from the imaging unit 10. The image data stored in the buffer memory 12 is read out in response to instructions from a control unit 18 which performs synchronous control of the whole camera. The image data read from buffer memory 12 is input to a data compression circuit 14 which performs well-known data compression processing on the image data. Finally, the image data which has been compressed is recorded in a memory on a memory card 16 via an I/O circuit (not shown).” EX1061 (“Juen”), 1:15-35.



235. This would facilitate smooth handling and aberration correction of sequential video frames, even when the camera might also have other intermittent, and thus non-synchronous, tasks to perform.

236. A POSA would understand such a buffer may be sized to suit expected use:

“The capacity of the buffer memory 24 may be selected by taking into account the number of photographs taken in rapid succession or, as described below, the processing power of irreversible encoder 28.”
Juen, 3:59-63.

237. POSAs would be motivated to buffer even compressed image data before aberration correction, as [6.c] requires:

“By compressing the stored image data before placing it in the buffer memory, the number of frames of image data possible for storage is increased. Furthermore, the capacity of the buffer memory may be decreased while maintaining transmission speed.” Juen, Abstract;

“Therefore, it is an object of the present invention to provide a video still camera with circuits which are small in scale. It is a further object of the present invention to provide a video still camera which is relatively inexpensive. Another object of the present invention is to provide a still camera with which continued photography is possible at a useful speed while using a small capacity buffer memory. It is yet a further object of the present invention to provide a video still camera which provides high resolution when performing photography of images with many image elements, while using a small capacity buffer memory. It is still a further object of the present invention to provide a video still camera which records an approximately constant

quantity of data on a memory card for each frame of image data.”

Juen, 2:8-24.

3. Limitation [6.d]

6.d	wherein at least one optical aberration in at least two frames of the digital video are identified using the in-camera software and the integrated circuit;
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238. As explained in detail in §§IX.B.2.d ([1.a]), IX.B.2.a ([1.a]), and IX.B.4 ([1.d]) above, Watanabe discloses using the integrated circuit and in-camera software to identify and correct at least one optical aberration in at least one frame of digital video.

239. As described in detail in §IX.B.2.a above, regarding [1.a], Watanabe was capable of identifying and correcting aberrations in successive frames, e.g., “in at least two frames of the digital video,” for the following reasons:

240. The video is, as explained in the ’685 specification (EX1001, 27:37-38), a series of still images, any one of which was expected to contain optical aberration associated with the lens, focusing point, and zoom position at image capture. JP-872, [0006]-[0008]; Watanabe, [0046]-[0049].

241. Watanabe captures video in a standard video format:

“the output signal of the CCD 3 is converted into a digital signal by the A/D converter 5 via the CDS circuit 4 at an optimal sampling frequency (for example, an integral multiple of the subcarrier frequency of the NTSC signal)” (JP-872, [0006]);

“output signals from the CCD 53 pass through the CDS circuit 54 and are converted by the A/D converter to digital signals at optimum sampling frequency (e.g. an integral multiple of sub-carrier frequency of an NTSC signal” (Watanabe, [0037]).

242. In 1953, NTSC issued a standard for a color television (video) signal carrying 30 (actually 29.97) frames per second (EX1017, I.F.2) with color information carried on a “color subcarrier” of 3.579545 megahertz (EX1017, III.A), from which the scanning frequencies and frame rate are derived (EX1017, I.F.2).

243. POSAs also would have known there was little point in Watanabe correcting a single frame in a digital video without also correcting distortion aberrations in other frames, which need to be aligned with each other when viewed.

4. Limitation [6.e]

6.e	wherein the at least one optical aberration from the optical lens mechanism of at least two frames of the digital video are corrected by using the digital signal processor to apply at least one digital filtration algorithm; and
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244. While the term “digital filtration algorithm” does not appear in the ’685 specification, that specification does refer to “mathematical algorithms for automatic correction of optical aberrations” (EX1001, 12:40-41) and states:

“the present system demonstrates that in-camera digital filtration outperforms better than external filters” (EX1001, 7:33-35);

“FIG. 2 describes digital image signal processing. After an analog signal (200) is captured, it is converted to a digital signal by an analog-to-digital converter (210). The signal is then forwarded to the digital signal processor (220) and filtered (230).” EX1001 31:65-32:2;

Item 230 in EX1001, FIG. 2 is labeled “Digital Filtration”:

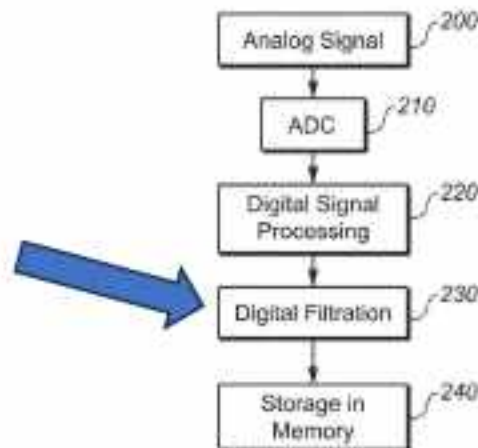


FIG. 2

245. Watanabe executes an “image process... on the image data in accordance with the process information” (Watanabe, [0062] (step 104)) for correcting distortion aberration and peripheral light intensity, and:

“data results from produced image data on which a distortion aberration correction process is executed according to a lens type, a focusing point and a zoom position, data results from produced image data on which a peripheral light intensity correction process is executed according to a lens type, a focusing point and a zoom position, and so forth can be recorded” Watanabe, [0049].

246. As described in §IX.B.6.i above, POSAs would understand “digital filtration” to be carried out with a “computational process or algorithm.” (EX1028, 193).

247. Watanabe’s “aberration correction process” (which is explained in detail in §IX.B.6 above regarding limitation [1.f]) can thus be aligned with ’685’s “mathematical algorithms for automatic correction of optical aberrations” and thus meets the “digital filtration algorithm” requirement of [6.e].

248. Watanabe meets [6.e] for successive video frames because, as described in detail in §IX.B.2.a above, Watanabe describes processing digital video.

F. Claim 7

249. Claim 7 can be parsed as follows:

7.PRE	The system of claim 6:
7.a	wherein the optical image aberrations include spherical, comatic, lens distortion, astigmatism, chromatic aberrations, curvature of field, pin cushion, barrel distortion, scattered light, and/or flare types of optical aberrations.

250. Watanabe meets [7.PRE] because Watanabe meets claim 6 as shown in detail in §IX.E above.

251. Watanabe meets [7.a] for the same reasons shown in detail in §IX.C above that it meets [2.a].

G. Claim 11

11.PRE	The system of claim 6:
11.a	wherein the digital video is filtered to correct at least one optical and/or digital aberrations after initial capture and before the digital video is initially sent to storage.

252. Watanabe meets [11.PRE] because Watanabe meets claim 6 as shown in detail in §IX.E above.

253. The '685 patent describes “digital aberrations” as “digital artifacts” requiring correction. EX1001, 8:15-17 (“In the case of digital aberrations, specific digital artifacts, such as aliasing and dust, must be corrected.”).

254. Watanabe meets [11.a] as follows:

255. Watanabe describes correlated double sampling (“CDS”) on the digital video after its initial capture and before storage:

“the digital camera... is composed of the following:... CDS (correlated double sampling) circuit 4,” “the CDS circuit 4 is a circuit for reducing noise for the CCD type image sensor” JP-872, [0006];

JP-872, Fig. 1 (CDS 4);

“a digital camera 100... is provided with a CDS (Correlated Double Sampling) circuit 54” Watanabe, [0035];

“the CDS circuit is a circuit for reducing noise for the CCD-type image photographing device” Watanabe, [0037];

Watanabe, Fig. 1A (CDS 54).

256. CDS removes noise from the video captured by “digital sensors.”

257. For sensors based on CCDs as disclosed by Watanabe:

“For a circuit processing AC coupled CCD signals, some type of sample and hold and signal conditioning circuit is required. One requirement is to perform some type of sampling operation, such as a correlated double sampling (CDS) to enhance signal-to-noise ratio of the CCD signals.” EX1034 (“Tsay”), 1:28-32;

“A CCD/CMOS digital camera with integrated drivers is reported. The chip uses a 32 x 24 pixels CCD Interline-Transfer image sensor... Correlated Double Sampling technique could be integrate[d] on each readout channel to suppress kTC and fixed-pattern noise.” EX1062 (“Gottardi”), at 1911 (Conclusions).

258. The ’685 specification teaches that a digital camera can use either CCD or CMOS image sensors, or even both:

“the digital sensor, whether CCD or CMOS” EX1001, 8:23-24;

“a digital camera with interchangeable CCD and CMOS sensors”.
EX1001, 9:14-15.

259. Both types of sensor can produce digital aberrations:

“Additional aberrations are linked to the unique design of each type of digital sensor, with trade-offs presented between types of CCDs or CMOS chips.” EX1001, 6:32-34.

260. For sensors based on CMOS:

“Correlated Double Sampling, or CDS, is a method employed to improve the signal to noise ratio (S/N) of integrating image sensors. By subtracting a pixel's ‘dark’ or ‘reference’ or ‘reset’ output (charge) level from the actual light-induced signal, static fixed pattern noise (FPN) and several types of temporal noise are effectively removed from the sensor's (APS Array) output.” EX1068 (“Lim”), 2:15-21;

“performing Correlated Double Sub-Sampling upon a pixel region of an APS array effectively subsamples the pixel region (in the analog domain) while also correcting for static fixed pattern noise (FPN) and several types of temporal noise.” EX1068 (“Lim”), 8:17-21.

261. Noise from the digital sensor, both generally and in the form of fixed-pattern noise, is a “digital aberration” in [11.a] because it is an image artifact from a digital sensor, e.g., a CCD or CMOS focal plane array, as opposed to an “optical aberration” introduced by the lens.

262. The ’685 patent distinguishes “digital aberrations,” which originate from the digital sensor, from “optical aberrations” which originate from the lens:

“The present system provides in-camera digital corrections to both optical and digital aberrations. In the case of optical aberrations, distinct lens-specific imperfections are caused by wide-angle, telephoto and zoom lens types.” EX1001, 8:11-14.

263. Watanabe’s CDS “filters” the “digital video” because the CDS circuit provides a form of high-pass filter that removes low frequency noise from images. This filter can be realized by comparing pixel values taken at different times:

“the sampling network operates in accordance with a correlated double sampling algorithm. The sampling network is operable to receive a single ended input in the form of a CCD output signal and then convert it to a double ended output from the amplifier. Two input sampling capacitors are provided for sampling the input signal onto one of two differential inputs with the amplifier being a differential amplifier. The DC reference level is sampled onto the first sampling capacitor during the generation thereof and, at a later time, the video signal level is sampled onto the second sampling capacitor. By equalizing the plates of the capacitors opposite to the positive and negative inputs of the amplifier, a differential input signal is provided on the differential input to the amplifier” EX1034 (“Tsay”) 1:63-2:10.

264. Watanabe’s CDS corrects the digital sensor after image capture but before storage, meeting [11.a]:

“output signals from the CCD 53 pass through the CDS circuit 54 and are converted by the A/D converter to digital signals” (Watanabe, [0037]);

“the digital signal processing circuit 56 sorts out the image data inputted from the A/D converter 55... and executes... correction” (Watanabe, [0038]);

“the CPU 57... processes image data by way of an image processing program in the control program. . . . the CPU 57 executes recording operation control of image data for the memory card 60” (Watanabe, [0042]);

“[D]ata results from produced image data on which a distortion aberration correction process is executed according to distortion aberration information, data results from produced image data on which a peripheral light intensity correction process is executed according to peripheral light intensity information, and so forth can be recorded.” Watanabe, [0048].

H. Claim 12

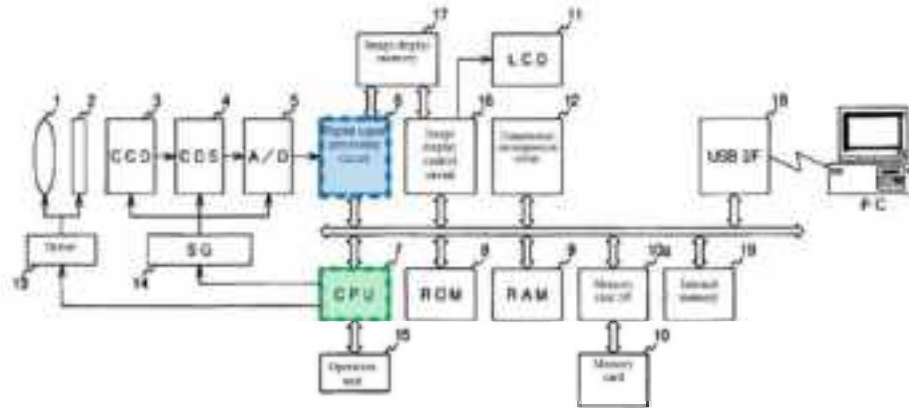
265. Claim 12 can be parsed as follows:

12.PRE	The system of claim 6:
12.a	wherein the integrated circuit may be a microprocessor, an application specific integrated circuit or a system on a chip.

266. Watanabe meets [12.PRE] because, as described in detail in §IX.E above, Watanabe meets claim 6.

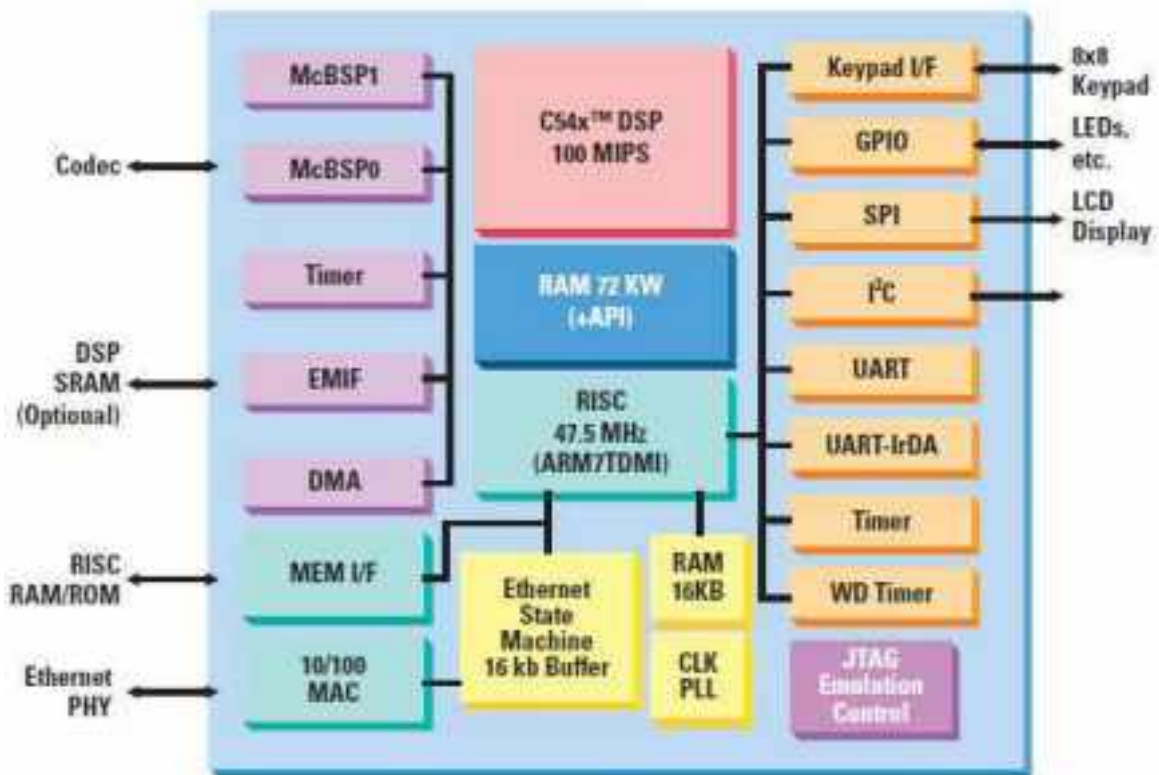
267. Watanabe meets [12.a] because an obvious integrated circuit implementation and design choice is a system-on-chip (“SoC”).

268. Watanabe leaves the CPU and digital signal processor implementation details to the POSA because Watanabe does not describe whether those components are implemented as discrete components or integrated in a system-on-chip (“SoC”) (JP-872, Fig. 1 (annotated below); Watanabe, Fig. 1B).



269. However, it was well known to combine CPU and DSP functions on a single chip. For example, the Product Bulletin for the Texas Instruments TMS320C5470 and TMS320C5471 System-Level DSPs, (EX1020) shows both a DSP and an ARM RISC CPU on a single chip (“integration of the DSP + RISC on a single chip):

TMS320C5471 DSP Block Diagram



The TMS320VC5471 DSP has all the features of the C5470 DSP with the addition of a 10/100 Base-T Ethernet MAC for easy LAN connection.

270. Computers, both general and special purpose, contain processors (often called “central processing units” or “CPUs”) which can carry out mathematical and logical operations defined in their structures as “instructions” which can be called for by programs provided to and executed by the CPUs.

271. Many dedicated CPUs, as found in digital cameras, need only a modest set of instructions to carry out the kinds of programs they’ll be asked to run. Such CPUs can be called “RISC” (for “Reduced Instruction Set Computer”) processors because their instruction sets are “reduced” compared to the larger

instruction sets of a general purpose CPU as found in a Windows or Macintosh computer.

272. One family of RISC processors is called “ARM” (for “Advanced RISC Machine”) processors. These are favored in dedicated applications because they are smaller (fewer transistors), draw less power, cost less, and are simpler to program than the processors found in general purpose computers.

273. Dedicated applications can be further served by integrating the CPU with other functions needed by that application, e.g., the A/D and DSP for image processing in a digital camera. This integration has several benefits:

- All the needed functions are in place and connected; this improves communication among those functions and facilitates shared access to memory and CPU, providing more rapid execution of those functions and quicker (less latency) delivery of results than discrete component implementations;
- All the needed functions are already specialized and partitioned optimally among DSP and other processors for the specific application;
- The resulting chip (often called an “SoC” for “System on Chip”) is smaller, less expensive, and likely draws less power than the array of separate chips otherwise needed for the specific application.

I. Claim 14

274. Claim 14 can be parsed as follows:

14.PRE	A digital imaging system for correcting image aberrations comprising:
14.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
14.b	wherein the optical lens mechanism is a zoom lens;
14.c	wherein the zoom lens changes focal length positions;
14.d	wherein when the digital video is forwarded to the digital signal processor and to memory;
14.e	wherein the integrated circuit uses system software to access the database to identify at least one optical aberration in at least one frame of the video at any focal length of a zoom lens configuration;
14.f	wherein the integrated circuit accesses the database to obtain at least one filtration correction algorithm to the optical image aberration of at least one frame in the video file and forwards the at least one filtration algorithms to the digital signal processor;
14.g	wherein the digital video is forwarded to the digital signal processor which applies at least one filtration algorithm to optimize the digital video and corrects the at least one optical image aberration in at least one video frame for the at least one focal length in the zoom lens configuration; and
14.h	wherein the corrected digital video is stored in memory.

1. Limitations [14.PRE], [14.a], [14.b], and [14.h]

14.PRE	A digital imaging system for correcting image aberrations comprising:
14.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
14.b	wherein the optical lens mechanism is a zoom lens;
14.h	wherein the corrected digital video is stored in memory.

275. Watanabe meets these claim 14 limitations for the same reasons

Watanabe meets the corresponding limitations in claim :

Limitation	Corresponding Limitation	Detailed Discussion
[14.PRE]	[1.PRE]	§IX.B.1
[14.a]	[1.a]	§IX.B.2
[14.b]	[1.b]	§IX.B.3
[14.h]	[1.g]	§IX.B.7

2. Limitation [14.c]

14.c	wherein the zoom lens changes focal length positions;
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276. The '685 specification mentions “the zoom lens changes focal-length positions” (EX1001, 16:47) but also:

“the zoom is moved to a new focal position” EX1001, 26:65;

“In the case of zooms, however, where the focal-length is not fixed, the adjustments must correlate to the changes in the focal length.” EX1001, 26:24-27; and

“The general problem with zoom lenses is the trade-off that must be made: To minimize the distortions of the widest possible focal length, distortions become maximized at the longest possible focal length, and vice-versa.” EX1001, 26:3-7.

277. Variations on the claim term “focal-length positions” were well known:

EX1048 (“Goosey”), Abstract (“ f_t is the focal length of the zoom lens in the telephoto position, and f_w is the focal length of the zoom lens in the wide-angle position.”).

278. From all this, a POSA would understand “the zoom lens changes focal-length positions” to describe changing the focal length of a zoom lens.

279. As described above in §IX.B.2.g above, Watanabe uses the term “zoom position” to describe the current focal-length setting of a zoom lens. This usage was well known:

EX1048 (“Goosey”), 1:24-30 (“efforts are being made to create more compact zoom lenses... producing high quality images over a large focal length range. More specifically, a zoom lens must maintain high image quality in each zoom position”).

280. Watanabe reflects this by referring to a lens having “zoom positions” in the plural:

Watanabe, [0047] (“correction values in accordance with focusing points and zoom positions are prepared in advance on a lens to lens basis”).

281. Watanabe thus meets [14.c] by disclosing “the zoom lens changes focal-length positions.”

3. Limitation [14.d]

14.d	wherein when the digital video is forwarded to the digital signal processor and to memory;
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282. Watanabe meets [14.d] for the same reasons it meets [1.e] (as explained in detail above in §IX.B.5 above) and [6.c] (as explained in detail in §IX.E.2 above).

4. Limitation [14.e]

14.e	wherein the integrated circuit uses system software to access the database to identify at least one optical aberration in at least one frame of the video at any focal length of a zoom lens configuration;
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283. Watanabe meets [14.e] because the in-camera software (“system software”) is capable of accessing the database and identifying at least one optical aberration in a video frame based on lens, focal length, and zoom position as explained in detail in §IX.B.4 for limitations [1.c]-[1.d].

284. As described in detail in §IX.B.2.a above, Watanabe discloses in-camera software (Watanabe’s “control program”) including an image processing program. The term “system software” does not appear in the ’685 specification, but a POSA would understand that term to include Watanabe’s control program as that is part of Watanabe’s system.

285. As described in detail in §IX.B.2.f above, Watanabe discloses that software is used to access the database of optical aberration correction by search criteria including the claimed “focal length of a zoom lens configuration” (Watanabe’s “zoom position” per §IX.B.2.g above).

286. As described in detail in §IX.B.2.a above, Watanabe can correct each frame of a digital video using the same approach as for a still photograph.

5. Limitation [14.f]

14.f	wherein the integrated circuit accesses the database to obtain at least one filtration correction algorithm to the optical image aberration of at least one frame in the video file and forwards the at least one filtration algorithms to the digital signal processor;
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287. The “video file” in [14.f] has no antecedent basis in claim 14, but relates to the term “video image file” in limitation [1.f], addressed in §IX.B.6.a.ii above. POSAs would have understood that Watanabe was capable of applying corrections to a frame in a video file:

“Compressed image data are Stored in the memory card 60 and the internal memory 69, as image data files.” Watanabe, [0039];

“the CPU 57 executes recording operation control of image data for the memory card 60, reproducing operation control of an image data file recorded in the memory card 60” (Watanabe, [0042]).

288. A POSA would have understood that a “filtration correction algorithm” includes a “specific sequence of operations” applied by the DSP; e.g.:

“In the operation of the data processing system 10, the general purpose processor 18 selects from a basic set of DSP operations to define a specific sequence of operations as the DSP algorithm to be executed by the DSP module 16.” EX1069 (“Intratater”), 6:37-40;

“The general purpose processor then retrieves operands required for execution of the selected DSP algorithm and/or instructions and data critical to the general purpose processor for controlling the DSP module 16 and loads them into the internal RAM array 22.” Intratater, 6:41-47;

“The general purpose processor then invokes the first DSP operation in the selected sequence by issuing the corresponding command to the control register of the DSP module 16. The DSP module then places the general purpose processor 18 in a continuous wait state while it performs the first DSP operation utilizing operands retrieved by the address generator 28 from the RAM array 22 and system memory.” Intratater, 6:47-54;

“Upon completion of the DSP operation, the DSP module cancels the continuous wait state and the general purpose processor 18 then either reads the status of the DSP module 16 or the result of the DSP operation or carries on with the execution of its normal program flow, which may be either invoking the next DSP operation in the selected sequence by issuing the appropriate command to the DSP module control register or performance of a general purpose task.” Intratater, 6:54-62;

“an image processing apparatus that is able to compress image data by various methods” (EX1070 (“Kashida”), 1:48-50);

“Data compressor 18a in turn comprises a programmable DSP (digital signal processor).” Kashida, 2:14-16;

“The DSPs can change their compression characteristics by changing the compression software programs loaded in them. These compression software programs, having suitable characteristics for the various apparatus, are stored in the respective ROMs. For instance, a high speed compression algorithm is stored in ROM 32b.” Kashida, 2:50-56;

“The digital signal processor 153 executes a main routine that can call various routines to perform the different aspects of image processing. The routines are stored in the Read-only Memory 177 or in some other form of non-volatile memory.” EX1072 (“Buchin”), 10:28-32;

“The DSP 162, however, does not contain power down data storage capability. All internal data required by the DSP 162, including OCR algorithms and image processing programs, must therefore be downloaded to the DSP 162 each time it is powered up to perform a processing function. The DSP 162 is configured such that the internal registers of the DSP 162 are accessed by the CPU 160 as input/output devices over the bus 164.” EX1071 (“Reddig”), 13:8-17.

289. Watanabe does not explain where the algorithms that its DSP applies are stored.

290. A POSA would have understood that while a DSP dedicated to a single algorithm could have that algorithm baked into it, DSPs used for the kinds of adaptive image processing considered in this matter require access to sets of

algorithms, one of which will suit at the given moment based on, e.g., the current lens type and setting.

291. As cited extensively above in this section, it was known to select and load algorithms from memory to provide particular signal processing (“filtration”) at the DSP to suit various needs.

292. A POSA would have stored or, at a minimum identified, in Watanabe’s database the particular DSP filtration algorithm needed for a particular aberration correction. Thus, Watanabe’s integrated circuit would “obtain” the correction algorithm by accessing the database using information identifying the algorithm, then “forward[ing]” that algorithm to the DSP so that it could apply the filter and correct the aberration.

293. POSAs would have understood that Watanabe was capable of applying corrections to a frame in a video file because Watanabe discloses data stored in memory “as image data files” (Watanabe, [0039]).

294. Watanabe meets [14.f] for the following reasons:

295. As described in detail in §IX.B.2.f above, Watanabe’s integrated circuit is capable of accessing table 20 or tables 70 (“the database”) to obtain distortion aberration and peripheral light intensity corrections for each lens, focal length, and zoom position.

296. As described in detail in §IX.B.6.a.i above, the corrections accessed in Watanabe's database are "digital filtration algorithms," so Watanabe meets the "at least one filtration correction algorithms" requirement of [14.f].

297. Watanabe meets the "forwards the at least one filtration algorithms to the digital signal processor" requirement of [14.f] because it teaches the digital signal processor accessing the database of corrections as described in detail above in this section and in §IX.B.2.f above regarding [1.a].

298. As described in detail in §IX.B.2.a above, Watanabe can obtain the correction information for each frame of a digital video using the same approach as for a still photograph.

6. Limitation [14.g]

14.g	wherein the digital video is forwarded to the digital signal processor which applies at least one filtration algorithm to optimize the digital video and corrects the at least one optical image aberration in at least one video frame for the at least one focal length in the zoom lens configuration; and
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299. Watanabe meets [14.g] because it teaches forwarding the video to the digital signal processor as described in detail in §IX.B.5 above regarding [1.e].

300. As described in detail in §IX.B.2.a above, Watanabe can correct each frame of a digital video using the same approach as for a still photograph.

301. Watanabe's digital signal processor is capable of applying the distortion aberration and peripheral light intensity corrections as a "filtration algorithm" to "at least one video frame" as described in detail in §IX.B.4 above

regarding limitation [1.d], §IX.B.6.a.i above regarding limitation [1.f], and §IX.I.5 above regarding limitation [14.f].

302. The corrections are “for... at least one focal length in the zoom lens configuration” because Watanabe describes selecting corrections based on zoom lens focal length (“zoom position”) as described in detail in §IX.I.2 above regarding [14.c].

303. Watanabe thus meets [14.g].

J. Claim 15

304. Claim 15 can be parsed as follows:

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

305. Watanabe meets [15.PRE] because it meets claim 14 per §IX.I above.

306. Watanabe meets most of [15.a] for the same reasons it meets [2.a] as described in detail in §IX.C above.

307. Watanabe meets the “vignetting” requirement of [15.a] by disclosing correction of peripheral light distribution as described in detail in §VI.B and §IX.A above.

K. Claim 17

308. Claim 17 can be parsed as follows:

17.PRE	The system of claim 14:
17.a	wherein each focal length of a zoom lens in at least one video image frame is analyzed for a different set of optical aberrations.

309. Watanabe meets [17.PRE] because it meets claim 14 as described in detail in §IX.I above.

310. Limitation [17.a] recites “each focal length of a zoom lens... is analyzed for a different set of optical aberrations.” As described in detail in §VIII.A.1 above, aberrations associated with each focal length for a given zoom lens are a “different set of optical aberrations.”

311. Watanabe meets [17.a] because tables 20 and 70 (the database) contain correction data for optical aberrations at each zoom position for each lens type, as described in detail in §IX.B.2.g above regarding limitation [1.a], §IX.I.4 above regarding limitation [14.e].

L. Claim 27

27	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for lens distortion aberrations.
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312. Watanabe meets claim 1 as described in detail in §IX.B above.

313. Watanabe meets claim 27 because it stores a “control program” that includes an “image processing program” that a POSA would understand contains “machine readable instructions” because Watanabe’s image processing program runs on CPU 57 (Watanabe, [0042] (“the CPU 57... processes image data by way of an image processing program in the control program.”)).

M. Claim 29

29	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for curvature of field aberrations.
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314. Watanabe meets claim 1 as described in detail in §IX.B above.

315. Watanabe meets claim 29 because, as described in detail in §IX.C above, Watanabe's image processing program (which, as described in detail in §IX.L above, includes machine readable instructions for corrections) corrects curvature aberrations: JP-872, [0007] ("distortion in the case of curvature aberration correction").

X. GROUND 2: WATANABE IN VIEW OF KISHIDA RENDERS OBVIOUS CLAIMS 3, 13, AND 19

A. Kishida

316. Kishida describes an approach to "Provide an appropriate image by achieving both shading correction and exposure correction or white balance correction." Kishida, Abstract.

317. Kishida discloses that performing such correction can be done in software:

"a program to make a computer perform image processing that processes the object image in which the object is represented and applies exposure correction or white balance correction to the said object image, and the image processing control processing that controls the said processing based on the prediction result of shading

that is predicted to occur in the aforesaid object image.” Kishida, [0020]

318. By “shading,” Kishida refers to what Watanabe calls “degradation of peripheral light intensity” (Watanabe, [0007]), which in turn is what is often called “vignetting” (as discussed in detail in §VI.B above).

319. Kishida discloses:

“An image processing unit control unit 104 controls image processing by the image processing unit 103 on the basis of a prediction result about shading predicted to be generated in an object image.” Kishida, Abstract;

“the exposure correction process or white balance correction process is controlled based on the prediction result of shading that is predicted to occur in the object image. Therefore, by controlling these processes so that the object image after shading correction does not become inappropriate even if further shading correction is performed after these processes, it will be possible to provide an appropriate image for which both shading correction and exposure correction or white balance correction are achieved.” Kishida, [0011].

320. This greatly reduces the processing power needed for shading correction compared to previous methods not involving prediction of shading:

“image processing to correct shadings in an image is generally a huge amount of processing” Kishida, [0008];

“the image processing control means controls the processing of exposure correction or white balance correction of the object image, which requires far less processing than image processing that performs shading correction on object images, so the real-time nature of the observation image display will not be lost.” Kishida, [0012].

321. Kishida explains that this “prediction result” is “predicted from the background image, which is an image captured separately from the aforementioned object image and does not represent the aforementioned object.” Kishida, [0015].

322. Kishida then “performs shading prediction based on the background image, as an example of a method for predicting shadings that occur when exposure correction or white balance correction processing is applied to an object image.” Kishida, [0016].

B. Watanabe in view of Kishida

323. As described in detail in §IX.A above and in addressing the claims covered in Ground 1 above, Watanabe describes correcting optical image aberrations in digital video including vignetting based on previous characterization of the lens used to capture in image, and offers a specific mathematical approach to correcting vignetting, but does not describe an approach to optimizing overall exposure in the image.

324. Kishida, while correcting vignetting, also describes “exposure correction control based on shading prediction” (Kishida, [0045], [0051]).

325. POSAs would have used Kishida's teachings in Watanabe's system to extend Watanabe's image processing functionality and provide a solution to correcting overall exposure of images without requiring "huge" additional processing power. This would be attractive to POSAs as over- or underexposure occur frequently apart from whether there is also vignetting, and correction of vignetting by itself, while producing a uniform distribution of exposure across the image, may result in an overall over- or underexposure.

326. POSAs would have had a reasonable expectation of success because Watanabe already provided the hardware supporting Kishida's techniques and Kishida teaches implementing its techniques in software:

Kishida, [0020] ("a program to make a computer perform image processing that processes the object image in which the object is represented and applies exposure correction or white balance correction to the said object image, and the image processing control processing that controls the said processing based on the prediction result of shading that is predicted to occur in the aforesaid object image").

327. A POSA would understand this program could be incorporated in Watanabe's "control program stored in the ROM 58" running on Watanabe's "CPU 57." (Watanabe [0042]).

C. Claim 13

328. Claim 13 can be parsed as follows:

13.PRE	The system of claim 6:
13.a	wherein the optical image aberration is vignetting;
13.b	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 comers of the at least two image frames or the digital signal processor applies both neutral density filtration in the image center and/or an algorithm to lighten the comers of the image of at least two image frames; and
13.c	wherein the image exposure for at least two frames in the digital video file is optimized to correct the vignetting.

1. Limitations [13.PRE] and [13.a]

13.PRE	The system of claim 6:
13.a	wherein the optical image aberration is vignetting;

329. Watanabe in view of Kishida meets [13.PRE] because, as described in detail in §IX.E above, Watanabe meets claim 6.

330. Watanabe in view of Kishida meets [13.a] because, as described in detail in §IX.A above, Watanabe corrects “degradation of peripheral light intensity” (Watanabe, [0007], [0032], [0048]-[0049], Fig. 8) and, as described in detail in §VI.B above, what Watanabe calls “degradation of peripheral light intensity” is often called “vignetting.”

2. Limitation [13.b]

13.b	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 comers <i>[sic]</i> of the at least two image frames or the digital signal processor applies both neutral density filtration in the image center and/or an algorithm to lighten the comers of the image of at least two image frames; and
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331. The word “comers” in [13.b] (and also in [3.b]) appears to be a typographical error and should read “corners,” as that term appears in the otherwise similar [19.b] and in relevant text in the ’685 specification:

EX1001, 10:4-6 (“vignetting, a type of aberration in which the corners of an image are exposed a stop less than the image's center area”);

EX1001, 16:23 (“a corner of the image”).

332. Watanabe shows the “periphery” of an image being the most distant part from the center of the image (Watanabe, FIG. 8), refers to “a peripheral portion” of an image (Watanabe, [0024], and teaches “correcting brightness of a peripheral portion of an image... so that it may be substantially the same brightness of the center portion” (Watanabe [0056]).

333. Since most cameras capture rectangular images, and the corners of a rectangle are the furthest portions from the center, a POSA would understand an image “corner” is a peripheral portion of an image.

334. Watanabe in view of Kishida meets [13.b] because Watanabe’s DSP “applies an algorithm to lighten the [corners] of the at least two image frames” as follows:

335. Watanabe explains that image brightness decreases from the center to a peripheral portion addresses the typical case of “degradation of light intensity of a peripheral portion grounded on the cosine fourth law.” Watanabe, [0024].

336. Watanabe then discloses “correcting brightness of a peripheral portion of an image according to the cosine fourth law so that it may be Substantially the same brightness of the center portion.” Watanabe [0056].

337. This cosine fourth law is a mathematical function of brightness versus distance from the image center (as shown in Watanabe, FIG. 8) so, as described in detail in §IX.E.4 above regarding [6.e], Watanabe’s “correcting brightness of a peripheral portion of an image according to the cosine fourth law” meets [13.b]’s “applies... an algorithm” requirement.

338. Since, as described in detail in §IX.E.3 above regarding limitation [6.d], Watanabe, and thus Watanabe in view of Kishida, can correct each frame of a digital video in the same manner as a still frame, POSAs would have understood that Watanabe in view of Kishida’s correction of vignetting applied to “at least two image frames” of a digital video.

3. Limitation [13.c]

13.c	wherein the image exposure for at least two frames in the digital video file is optimized to correct the vignetting.
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339. Watanabe in view of Kishida meets [13.c] because Kishida, while correcting vignetting, also describes “exposure correction control based on shading prediction” (Kishida, [0045]):

“The image processing system... has an image processing means that applies processing to an object image in which an object is

represented and performs correction of the exposure of the object image... and an image processing control means that controls such processing based on the prediction result of shading that is predicted to occur in the aforesaid object image.” Kishida, [0010];

“this image processing system can also be used to apply shading correction to object images” Kishida, [0015].

340. Kishida explains that the “prediction result” which controls the image processing system is “predicted from the background image, which is an image captured separately from the aforementioned object image and does not represent the aforementioned object.” Kishida, [0015].

341. A POSA would understand Kishida’s coordinated correction of vignetting and overall exposure to meet [13.c]’s “image exposure... optimized to correct the vignetting.”

342. Since, as the ’685 specification teaches that “video be viewed as merely a very rapid (30 to 60 frames per second) application of still photography (EX1001, 27:37-38), Kishida can apply this optimization to each frame of a digital video in the same manner as optimizing a single still photograph.

D. Claims 3 and 19

343. Claim 3 can be parsed as follows:

3.PRE	The system of claim 1:
3.a	wherein the optical image aberration is vignetting;

3.b	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
3.c	wherein the image exposure is optimized to correct the vignetting.

344. Claim 19 can be parsed as follows:

19.PRE	The system of claim 14:
19.a	wherein the optical image aberration is vignetting;
19.b	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 at least one image frame 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 of at least one image frame; and
19.c	wherein the image exposure for at least one frame in the digital video file is optimized to correct the vignetting.

345. Watanabe in view of Kishida meets limitation [3.PRE] because, as described in detail in §IX.B above, Watanabe meets claim 1.

346. Watanabe in view of Kishida meets limitation [19.PRE] because, as described in detail in §IX.I above, Watanabe meets claim 14.

347. Watanabe in view of Kishida meets the remaining claim 3 and 19 limitations for the reasons described in detail in §X.C above that Watanabe in view of Kishida meets the corresponding limitations in claim 13 as listed below:

Limitation	Corresponding Limitation	Detailed Discussion
[3.a], [19.a]	[13.a]	§X.C.1
[3.b], [19.b]	[13.b]	§X.C.2
[3.c], [19.c]	[13.c]	§X.C.3

XI. GROUND 3: WATANABE IN VIEW OF KITA RENDERS OBVIOUS CLAIMS 4, 8, 9, AND 16

A. Kita

348. Kita describes correcting an image affected by aberrations from a lens by transforming that image with a fast Fourier transform (“FFT”) into the spatial frequency domain, filtering the transformed image while in the spatial frequency domain, then recovering the filtered image by transforming with an inverse fast Fourier transform (“IFFT”) back to image space:

“To restore an image to the frequency characteristics of an original image through a filter process using an inverse function” Kita, Abstract;

“[I]ts task is to provide an image capturing apparatus and image restoring method that can restore images based on the frequency characteristics of the original image by defining the inverse function of the amplitude transfer function in advance for the zooming amount, the defocusing amount, and the diaphragming amount, and performing filter processing using the said inverse function.” Kita, [0008];

“The image capturing device of this invention is a device that when an image after passing through the optical system is captured by the

image capturing means and the captured image data is processed by the image processing means, the image restoration means restores an image after passing through the optical system to an image with the frequency characteristics before passing through the optical system using the inverse function of the transfer function corresponding to the amount of optical adjustment to the optical system for the image data obtained by the image capturing means.” Kita, [0009];

“In order to generate an image filtered by an optical system lens, an image of a certain block is cropped from the original image, and a frequency-domain image is generated from the cropped time-domain image. This frequency-domain image can represent the image on the frequency axis. Next, this frequency-domain image is multiplied by the filter of the inverse function of the transfer function according to the amount of optical adjustment for the optical system using a multiplier. Finally, the result of this multiplication is converted from the frequency domain back to the time domain, and in this way, it is possible to generate a lens-filtered image.” Kita, [0010];

“Fig. 1 is a diagram of generating a lens-filtered image. Thus, in order to generate a lens-filtered image as shown in Fig. 1, a 512x512 image B(2) is cropped from the original image A(1), and Fourier transformation (FFT) 3 is applied to image B(2) to generate FFT image 4. This FFT image 4 can represent the image on the frequency axis. Next, this FFT image 4 is multiplied by the MTF filter 5 using a multiplier 6. Finally, inverse Fourier transformation (IFFT) 7 is applied to the result of this multiplication to generate a lens-filtered IFFT image 8.” Kita, [0026].

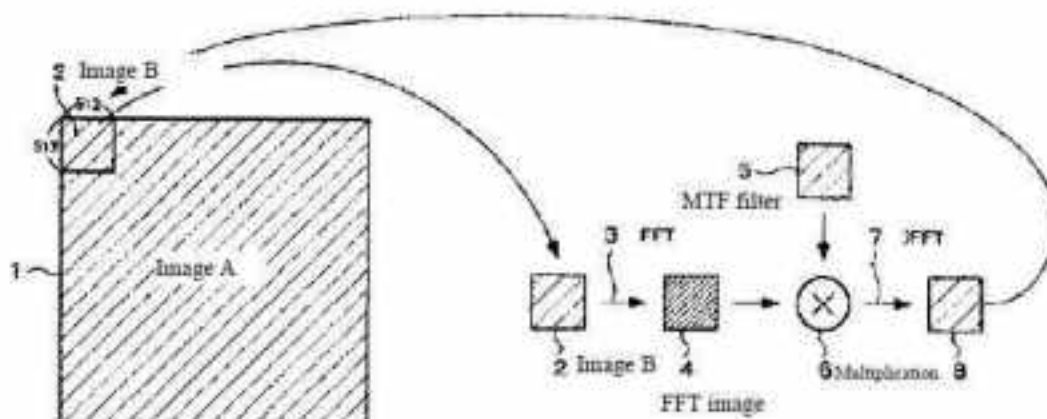


Diagram of generating a lens-filtered image

349. Fourier transforms and their practical digital versions, the fast Fourier transform (FFT) and its inverse (IFFT), are described in detail in §VIII.A.3 above.

350. As described in detail in §VIII.A.3 above, applying a filter in the spatial frequency domain (i.e., after the original image has been transformed by the initial FFT) reduces the strength of some spatial frequencies in the image more than others.

351. While simple filters can produce useful results (e.g., reduce noise or soften the image by cutting or reducing the high spatial frequencies as shown in §VIII.A.3 above), Kita's "MTF filter" represents the inverse of the MTF (for "Modulation Transfer Function," Kita, [0002]), which is the Fourier transform of how that lens renders the image of a very narrow bright point in an otherwise dark field.

352. The MTF shows how much each spatial frequency in an image cast by a lens is reduced (lowered in contrast). Typically, higher spatial frequencies (carrying finer detail in the image) are reduced more. Lens aberrations result in more, and more complex patterns of, reductions in higher spatial frequencies. Examples of this are shown below (EX1048 (“Goosey”), FIG. 4A), where the curves are the MTFs for various states of aberration:

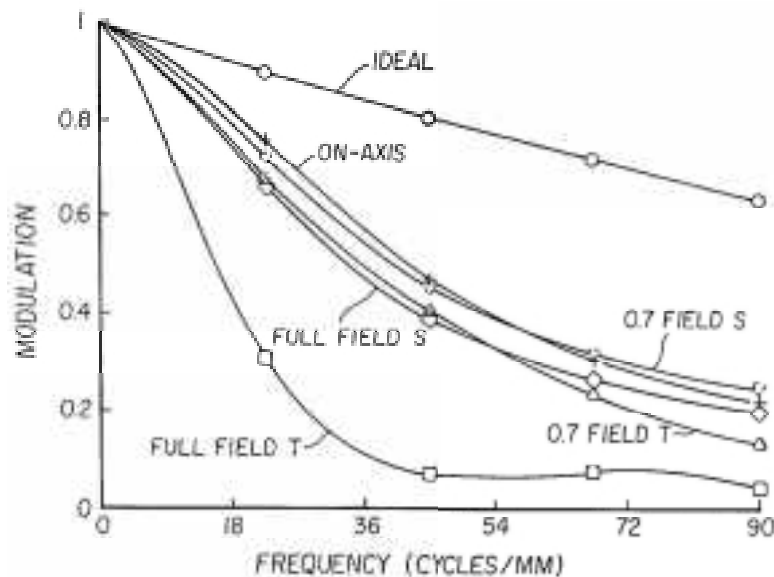


FIG. 4A

353. Kita’s MTF filter is used to undo the effects of the lens’ aberrations on the image, so it carries the inverse of the lens’ MTF, which boosts higher spatial frequencies, as in the example shown below (Kita, FIG. 2):

[Fig. 2]

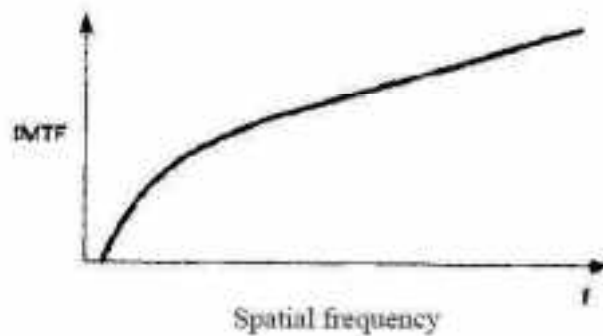


Diagram showing the IMTF curve

354. Kita's MTF filter represents the lens at a particular set of zoom positions, focusing points, and other settings, so MTF filters must be calculated from mathematical simulation of the lens design or by taking photos with the lens at various combinations of settings:

“[I]t is possible to generate an image before passing through the lens if the filter of the curve of the inverse function of the curve of the transfer function can be obtained in accordance with the amount of optical adjustment for the optical system.” Kita, [0014];

“In the case of a lens with aberration, the intensity distribution of the image relative to the object point has a broadening effect. This point image intensity distribution can be decomposed into a polynomial sine wave function consisting of sine waves (cos) at various frequencies by Fourier expansion. The amplitude varies with frequency, generally decreasing with higher frequencies. Therefore, since the synthesis of the sine waves constitutes the point image intensity distribution,

knowing the modulation reduction of the amplitude modulation for each sine wave at each frequency indicates the entire imaging performance of the system with respect to the object point.” Kita, [0021].

B. Watanabe in view of Kita

355. Watanabe does not describe a detailed methodology for correcting optical aberrations aside from vignetting.

356. As cited in §XI.A above, Kita provides detailed explanations for correcting optical aberrations using principles and techniques based on Fourier optics and inverse MTF filters for a lens under different “amount of optical adjustment” values including zoom lens position (“the zooming amount”) and focus (“the defocusing amount”). Kita, [0008].

357. POSAs would have had reasons to use Kita’s filtering and image restoration teachings in Watanabe’s system to achieve corrections for certain aberrations in addition to those explicitly addressed in Watanabe.

358. This would, within a POSA’s skills and knowledge, combine familiar techniques and components (Kita’s image restoration technique with Watanabe’s imaging and image processing system) yielding predictable results.

359. POSAs would have had a reasonable expectation of success because Watanabe already provided the hardware supporting Kita’s techniques and Kita teaches its techniques as logical and mathematical procedures which can be

implemented in software. A POSA would understand this software could be incorporated in Watanabe's "control program stored in the ROM 58" running on Watanabe's "CPU 57." (Watanabe [0042]).

360. POSAs would have known that Kita's technique applied to Watanabe's digital video captures because Kita's technique applied to images and, as taught by the '685 specification (EX1001, 27:37-38), a digital video is a series of still images.

C. Claims 4, 8, 9, and 16

361. Claim 4 can be parsed as follows:

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

362. Claim 8 can be passed as follows:

8.PRE	The system of claim 6:
8.a	wherein the digital signal processor applies at least one fast Fourier transform (FFT) algorithm to correct the at least one optical image aberration.

363. Claim 9 can be parsed as follows:

9.PRE	The system of claim 6:
9.a	wherein the digital signal processor applies a fast Fourier transform (FFT) algorithm to correct digital aberrations of at least two frames in the digital video.

364. Claim 16 can be parsed as follows:

16.PRE	The system of claim 14:
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16.a	wherein the digital signal processor applies a fast Fourier transform (FFT) algorithm to correct optical and/or digital aberrations in the digital video.
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1. Limitations [4.PRE], [8.PRE], [9.PRE], and [16.PRE]

365. Watanabe in view of Kita meets limitations [4.PRE], [8.PRE], [9.PRE], and [16.PRE] because Watanabe meets the related independent claims as listed below:

Limitation	Independent Claim	Detailed Discussion
[4.PRE]	1	§IX.B
[8.PRE], [9.PRE]	6	§IX.E
[16.PRE]	14	§IX.I

2. Limitations [4.a], [8.a], and [16.a]

366. Limitations [4.a] and [8.a] recite the DSP “applies at least one fast Fourier transform (FFT) algorithm” to correct “at least one optical image aberration,” while [16.a] recites “to correct optical... aberration in the digital video.”

367. Watanabe in view of Kita meets [4.a], [8.a], and [16.a] because Kita describes correcting optical image aberrations by transforming an image using FFT, applying an “MTF filter” comprising the inverse of the lens MTF, then recovering the original image corrected for lens aberrations by inverse FFT:

“[I]n order to generate a lens-filtered image as shown in Fig. 1, a 512x512 image B(2) is cropped from the original image A(1), and Fourier transformation (FFT) 3 is applied to image B(2) to generate

FFT image 4. This FFT image 4 can represent the image on the frequency axis. Next, this FFT image 4 is multiplied by the MTF filter 5 using a multiplier 6. Finally, inverse Fourier transformation (IFFT) 7 is applied to the result of this multiplication to generate a lens-filtered IFFT image 8.” Kita, [0026];

“The same is true in the case of applying restoration filtering. If the MTF filter 5 of the IMTF curve of the inverse function of the MTF curve as shown in Fig. 2 can be obtained, it will be possible to generate an image before passing through the lens.” Kita, [0027].

368. Kita’s “MTF correction filtering” is performed “through an MTF inverse function table 87” with parameters determined from optical system settings including zoom value, defocusing value, and “diaphragming amount” (e.g., iris) parameters:

“[0059] In step S16, the zooming amount, defocusing amount, diaphragming amount, and image height are used as keys to select MTF correction filters. Specifically, in Fig. 8, MTF correction filtering is performed for each image height using the MTF inverse function table 87 based on the results of the FFT calculation by the FFT calculation unit 83. The method of MTF correction filtering is as shown in the section on details of MTF restoration filtering. However, since parameters including the zooming amount, defocusing amount, and diaphragming amount exist, the MTF correction filter in the MTF inverse function table 87 must be determined according to each parameter.

[0060] The MTF correction filter in the MTF inverse function table 87 is selected and determined by referring to a predetermined table using the zooming amount, defocusing amount, and diaphragming amount as keys.

[0061] In step S17, interpolation processing of the MTF correction filter is performed. Specifically, if the zooming amount, the defocusing amount, or the diaphragming amount does not exist in the MTF inverse function table 87 in Fig. 8, MTF interpolation processing unit 88 performs MTF correction filter interpolation processing for MTF inverse function table 87.” Kita, [0059]-[0061].

369. The MTF filter corrects for the optical aberrations introduced by the lens:

“[T]he image restoring means restores the image B obtained by the image processing means to the image 8 with the frequency characteristics prior to passing through the optical system using the MTF filter 5 as the inverse function of the transfer function according to the amount of optical adjustment to the optical system.” Kita, Abstract;

“[I]n the case of restoring the filter, it is possible to generate an image prior to passing through the lens if the filter of the curve of the inverse function of the curve of the transfer function can be obtained in accordance with the amount of optical adjustment for the optical system.” Kita, [0011];

“The same is true in the case of applying restoration filtering. If the MTF filter 5 of the IMTF curve of the inverse function of the MTF curve as shown in Fig. 2 can be obtained, it will be possible to generate an image before passing through the lens.” Kita, [0027].

370. Watanabe in view of Kita further meets [16.a] because Watanabe corrects “optical aberrations” in digital video as described in detail in §IX.E.3 regarding limitation [6.d].

3. Limitation [9.a]

9.a	wherein the digital signal processor applies a fast Fourier transform (FFT) algorithm to correct digital aberrations of at least two frames in the digital video.
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371. Kita teaches that during the image restoration process the IFFT image (the corrected image after transform back to image space) can be adversely affected by how the starting image is handled:

“If image B(2) of 512x512 is cropped and FFT processed, but simply cropped from image A(1) and filtered by the MTF filter 5, it is considered that edges may have occurred at the boundary line between the generated IFFT image and the IFFT image. Therefore, the IFFT image generated by filtering may be tiled, resulting in a very unsightly image.” Kita, [0039].

372. The tiling and “unsightly image” are examples of the claimed “digital aberrations” because they are image defects produced in digital computation, not by optical aberrations of a lens. This aligns with the explanation of the claim term

in the '685 specification: “In the case of digital aberrations, specific digital artifacts, such as aliasing and dust, must be corrected.” EX1001, 8:14-16.

373. Kita corrects these digital aberrations by sampling smaller blocks of pixels within the image: “In order to avoid this phenomenon, the actual image to be cropped is made smaller and processed as 512x512 during FFT processing.” Kita, [0040].

374. Since, as described in detail in §IX.E.3 above regarding limitation [6.d], Watanabe, and thus Watanabe in view of Kita, can correct each frame of a digital video in the same manner as a still frame, POSAs would have understood that Watanabe in view of Kita’s correction of vignetting applied to “at least two image frames” of a digital video.

XII. GROUND 4: WATANABE IN VIEW OF TAKANE RENDERS OBVIOUS CLAIMS 10, 18, 28, AND 30

A. Takane

375. Takane describes image processing for “dynamic images,” which is a term that Takane distinguishes from still images: Takane, [0011] (“the image (a still image or dynamic images) which shows the subject”). A POSA would understand that Takane’s “dynamic images” are moving pictures, or video.

376. Takane receives those images from a digital video camera:

“photographing device (such as a digital still camera or a digital video camera or the like) in which an image is acquired by digital data and

recorded on a recording medium (such a device is called a ‘digital photographing device’ hereinafter)” Takane, [0006].

377. The camera provides corrections to “pin-cushion distortion” and “barrel distortion” lens aberrations:

“[D]istortion arises at the periphery of the acquired image due to refraction of the lens. Such distortion is generally called optical distortion, and is classified into the following two types: ‘pin-cushion distortion’ in which the corner portions of the image extend outwardly, and ‘barrel distortion’ in which, conversely, the corner portions contract.” Takane, [0005];

“[T]he digital image data which is obtained by photographing is subjected to optical distortion correction by the selected correcting section” Takane, [0016];

“[A] first distortion correction circuit 56 and a second distortion correction circuit which serve as correcting sections and are for correcting optical distortion[.]” Takane, [0043].

378. Takane’s camera also performs other corrections:

“the digital image data is subjected to, for example, various types of correction processings such as white balance adjustment, gamma correction, sharpness correction, and the like” Takane, [0044].

B. Watanabe in view of Takane

379. Watanabe describes “distortion aberration correction or peripheral light intensity correction” (Watanabe, [0009]) but does not describe correcting pin-

cushion or barrel distortions in particular, or other corrections such as white balance adjustment.

380. POSAs would have had reasons to combine Takane's teachings of white balance adjustment and correction of pin-cushion and barrel distortions with Watanabe's image processing in order to improve and extend Watanabe's functionality. Adding these capabilities would improve the value and utility of a camera without requiring additional circuitry.

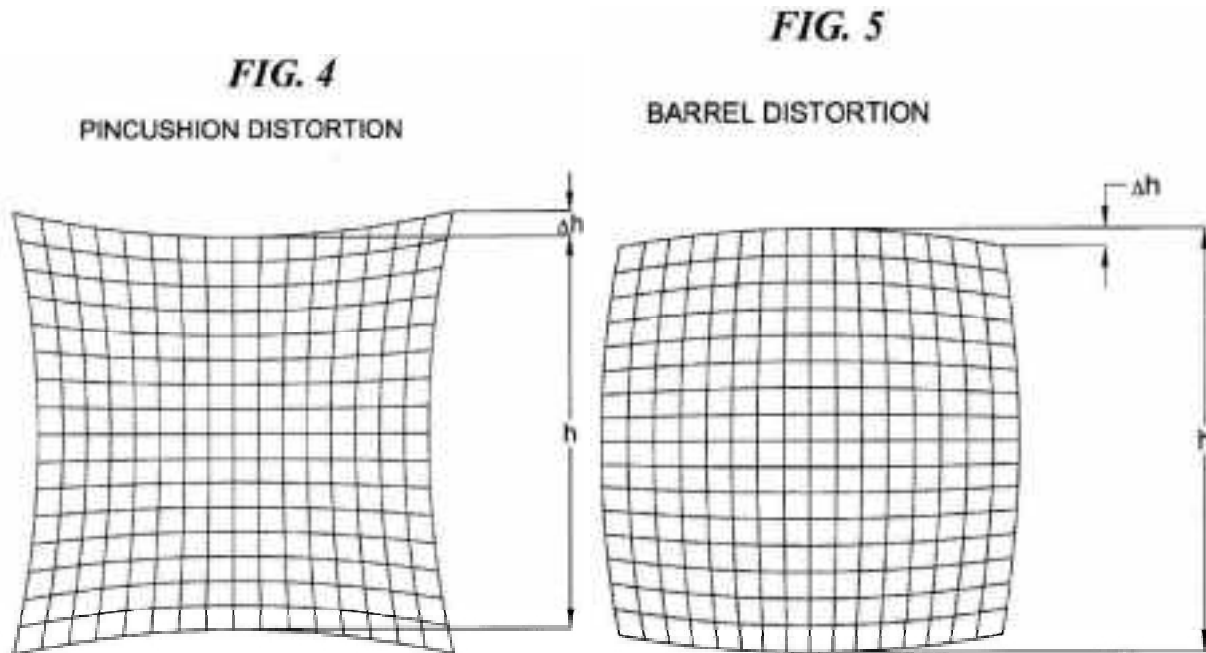
381. As described in detail in § IX.C above, Watanabe describes correcting lens distortion:

Watanabe, [0086] ("a lens distortion aberration rate at each focusing point and zoom position is determined in advance and so forth are known as a distortion aberration correction process").

382. Of the range of lens distortion aberrations, Takane specifically addresses correction of pin-cushion (often called "pincushion") and barrel distortion:

Takane, [0005] ("distortion arises at the periphery of the acquired image due to refraction of the lens. Such distortion is generally called optical distortion, and is classified into the following two types: "pin-cushion distortion" in which the corner portions of the image extend outwardly, and "barrel distortion" in which, conversely, the corner portions contract.").

383. Those two types of image distortion are shown below in FIGs. 4 and 5 from EX1074 (U.S. Patent No. 6,816,625, “Lewis”), representing images of a rectangular grid:



384. POSAs would have had a reasonable expectation of success because Takane teaches correcting images in a “distortion correction circuit” operating on digital image data as shown below.

“a second distortion correction circuit which serve as correcting sections and are for correcting optical distortion” Takane, [0043];

“The digital image data... is inputted via the bus 60 to the second distortion correction circuit 56 [*sic; should be 58*]” Takane, [0053]²;

² A POSA would have understood that Takane’s reference to “second distortion circuit 56” in [0053] is a typographical error that should refer to “second distortion circuit 58” because Takane numbers the first distortion circuit as 56. *See, e.g.*, Takane, Fig. 2 (circuits 56 and 58).

“In the second distortion correction circuit 58... processing for correcting the optical distortion is carried out. Namely, when a still image is photographed, the optical distortion can be corrected at a high correction accuracy.” Takane, [0063].

385. Takane also has a “first distortion correction circuit” which corrects at lower accuracy, to be used only for low-quality video in cameras with low processing capability: Takane, [0016] (“a plurality of correction sections which correct optical distortion of digital image data are provided. The plural correction sections have respectively different correction accuracies, and the processing speeds thereof also different in accordance with their correction accuracies.”).

386. POSAs would have known the function of Takane’s high-accuracy “second distortion correction circuit” could be accomplished by adding Takane’s corrections to Watanabe’s “control program” software running on Watanabe’s CPU 57 to execute corrections in Watanabe’s digital signal processor.

387. Takane also adjusts white balance in the image:

Takane, [0044] (“At the signal processing circuit 50, the digital image data is subjected to, for example, various types of correction processings such as white balance adjustment”).

388. The term “white balance” refers to errors in overall color in the image due to the color characteristics of the lighting on the subject:

“Currently, the automatic white-balance correction method is in wide spread use in the digital camera, digital video camera or a PC camera. However, the variation of natural light due to different time or weather condition and the effect of artificial illumination may cause errors in color tones as taking pictures by a camera or video camera. For example, the picture will show yellow color when the color temperature of light source is low, and blue color when the color temperature of light source is high. Therefore, the high color temperature (8500K) of light source from the fluorescent lamps commonly used in our everyday life will make the color of picture to be of blue color. Moreover, the specific wavelength of the fluorescent lamps may also make the color of picture to be of green color. As such, there is a need to perform an adjustment such that the color of the captured object is not affected by the circumstance. Such an adjustment is performed by white-balance correction, which allows the captured picture to be white-balanced in color. That is, the color of a white object is always shown to be white under any light sources.” EX1075 (“Hsieh”), 1:14-35;

“For digital cameras, if white balancing is not performed well then captured images may appear to have a color bias or some colors in a captured image may not appear natural compared to other colors in the captured image.” EX1035 (“Dorrell”), [0003];

“adjusting the white balance of the first image using the determined color transform” Dorrell, [0025];

“The regions identified by the mask in the image captured without the flash 812 may be compared to the corrected flash-only image. The results of this comparison may then be used to determine a white point for the no-flash image. This white point information may be used to remove any color bias in the no-flash image to produce a corrected no-flash image with substantially similar color appearance to the corrected flash-only image... the new synthetic fill flash image has a consistent color appearance in areas illuminated primarily by flash and the ambient illuminant. This results in a more natural looking image.” Dorrell, [0145]-[0146].

389. POSAs would have known that Takane’s white balance adjustment could be carried out in Watanabe’s system, again by adding to Watanabe’s “control program.”

390. Watanabe’s system with software implementing at least Takane’s white balance adjustment and correction of pin-cushion and barrel distortions is referred to herein as Watanabe in view of Takane.

C. Claims 10 and 18

391. Claims 10 and 18 can be parsed as follows:

10.PRE	The system of claim 6:
10.a	wherein the digital signal processor applies color filtration to at least two frames of the digital video image.
18.PRE	The system of claim 14:
18.a	wherein the digital signal processor applies color filtration to at least one frame of the digital video image.

1. Limitations [10.PRE] and [18.PRE]

10.PRE	The system of claim 6:
18.PRE	The system of claim 14:

392. Watanabe in view of Takane meets [10.PRE] and [18.PRE] because Watanabe meets claims 6 (per §IX.E above) and 14 (per §IX.I above) respectively.

2. Limitation [10.a]

10.a	wherein the digital signal processor applies color filtration to at least two frames of the digital video image.
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393. As described in detail in §IX.B.6.a.i above, the '685 patent's use of the term "digital filtration" refers to digital image signal processing (EX1001 31:65-32:2, Fig. 2).

394. Takane's "white balance adjustment" is performed by digital image signal processing:

"At the signal processing circuit 50, the digital image data is subjected to, for example, various types of correction processings such as white balance adjustment" Takane, [0044].

395. As described in detail in §XII.B above, "white balance adjustment," both generally and by Takane, adjusts overall color in an image, and so "applies color filtration," to both still and "dynamic" (video) digital images:

"the image processing circuit 46 is structured to include a signal processing circuit 50 which, regardless of whether the image is a still image or dynamic images, carries out predetermined digital signal processings on the inputted digital image data" Takane, [0043].

396. When a DSP adjusts an image white balance, it applies color filters, thus performing “color filtration:”

“[T]he white balance of the flash-only image FOI’ is adjusted using predetermined color properties of the light provided by the flash 812, in the color space of the camera 800 to determine a corrected flash-only image FOI". The color properties for a camera that is sensitive to a number, N, of Spectral bands may be represented by N color factors. The N color factors represent the response of N color filters of the camera 800, to the light provided by the flash 812.” Dorrell, [0155].

397. Takane discloses “a photographing mode selecting section for selecting at least which of a still image photographing mode and a dynamic image photographing mode the subject is to be photographed in” (Takane, [0015]). In dynamic image mode, Takane’s camera captures a succession of still images, which a POSA would understand to be video frames. Takane then corrects each of those: “a control section which, on the basis of results of selection by the photographing mode selecting section, selects the correction section, and carries out control such that the optical distortion of the digital image data is corrected by the selected correction section” (Takane, [0015]).

398. Takane thus “applies color filtration to at least two frames of the digital video image”.

3. Limitation [18.a]

18.a	wherein the digital signal processor applies color filtration to at least one frame of the digital video image.
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399. Watanabe in view of Takane meets [10.a] which addresses “at least two frames of the digital video image,” so Watanabe in view of Takane meets the lesser requirement of [18.a] which addresses only “at least one frame of the digital video image.”

D. Claims 28 and 30

400. Claims 28 and 30 can be parsed as follows:

28	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for pin cushion aberrations.
30	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for barrel distortion aberrations.

401. Claims 28 and 30 both depend from claim 1. Watanabe in view of Takane meets claim 1 for the reasons, described in detail in §IX.B above, Watanabe meets claim 1.

402. As described in detail in §IX.L above, Watanabe’s “control program” comprises machine readable instructions to correct for aberrations.

403. As described in detail in §XII.B above, Takane corrects for pin-cushion distortion aberration, and Takane’s pin-cushion distortion correction could be accomplished by adding Takane’s corrections to Watanabe’s “control program”

software running on Watanabe's CPU 57 to execute corrections in Watanabe's digital signal processor.

404. Watanabe in view of Takane thus "includes machine readable instructions for the system to correct for pin cushion aberrations" and so meets Claim 28.

405. As described in detail in §XII.A above, Takane corrects barrel distortion aberration, and Takane's barrel distortion could be accomplished by adding Takane's corrections to Watanabe's "control program" software running on Watanabe's CPU 57 to execute corrections in Watanabe's digital signal processor.

406. Watanabe in view of Takane thus "includes machine readable instructions for the system to correct for barrel aberrations" and so meets Claim 30.

407. Watanabe in view of Takane thus meets Claim 30.

XIII. GROUND 5: WATANABE+HISAMATSU RENDERS OBVIOUS CLAIMS 22, 23, AND 25

A. Hisamatsu

408. Hisamatsu states:

"[T]he optical lens provided in a conventional electronic still camera exhibits a characteristic that the amount of light at the periphery of the lens is reduced compared to the center of the lens, and also has aberrations such as spherical aberration, coma aberration, and chromatic aberration." Hisamatsu, [0002].

409. As described in detail in §VIII.A.1 above, spherical aberration, coma aberration, and chromatic aberration were known at least since 1857.

410. Hisamatsu digitally (“arithmetically”) corrects images for the effects of the known aberrations of a lens at specific settings:

“[T]he electronic still camera of this invention has a characteristic that it is equipped with an optical lens; an image capture element that receives the object image formed by the optical lens and then outputs an image signal; an analog-to-digital converter that converts the image signal into digital data; a buffer memory in which the digital data is written; a memory in which the optical characteristic data of the aforesaid optical lens is stored; an arithmetic operation unit that corrects the aforesaid digital data using the optical characteristic data” Hisamatsu, [0005];

“the optical characteristic data of the aforesaid optical lens is at least one of the peripheral light amount reduction data or the aberration data” Hisamatsu, [0007];

“Fig. 1 shows a block diagram of the key components of the 1st embodiment of the electronic still camera of this invention. . . . 5 is an arithmetic operation circuit that receives data from the read-only memory (ROM) 6 (to be described later) and performs data arithmetic operation processing” Hisamatsu, [0019].

B. Watanabe+Hisamatsu

411. As described in detail in §XIII.A above, Hisamatsu discloses digitally correcting the effects on digital images of spherical, chromatic, and coma aberrations from optical lenses forming those images.

412. Watanabe describes correcting distortion aberrations but does not specifically describe correcting spherical, chromatic, or coma aberrations.

413. POSAs would have had reasons to include Hisamatsu's spherical, chromatic, or coma aberration corrections in Watanabe because this would have improved Watanabe's system and extended its distortion correction capabilities.

414. POSAs would have found it desirable and practical to add Hisamatsu's corrections of spherical, chromatic, and coma aberrations to the machine readable instructions for Watanabe's digital image processing program, e.g., because this is how Watanabe implemented its digital image processing.

415. POSAs would have had a reasonable expectation of success because the programming to implement Hisamatsu's corrections on a digital signal processor was within the POSA's ordinary skill. This reflects the widespread and well-known use of DSPs controlled by CPUs to perform image data processing:

“The TMS320C8x digital signal processor (DSP) is a single-chip, multiprocessor device for use in image processing” EX1019, SL: 1-1;

“A single 'C8x contains up to five powerful, fully programmable processors: a master processor (MP) and up to four parallel processors

(PPs). The MP is a 32-bit RISC (reduced instruction set computer) processor” EX1019, iii.

416. POSAs would have had a reasonable expectation that Hisamatsu’s corrections to still images would work with digital video because digital video is a series of still images as explained in detail in §IX.B.4 regarding limitations [1.c] and [1.d].

C. Claims 22,-23 and 25

417. Claims 22, 23, and 25 can be parsed as follows:

22	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for spherical aberrations.
23	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for chromatic aberrations.
25	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for comatic aberrations.

418. Claims 22, 23 and 25 all depend from claim 1. Watanabe+Hisamatsu meets claim 1 because, as described in detail in §IX.B above, Watanabe meets claim 1.

419. As described in detail in §§XIII.A-B above, Watanabe+Hisamatsu provides a system that includes “machine readable instructions” for correcting spherical (claim 22), chromatic (claim 23), and coma (claim 25) aberrations.

420. Watanabe+Hisamatsu thus meets claims 22, 23, and 25.

XIV. GROUND 6: WATANABE IN VIEW OF TURNER RENDERS OBVIOUS CLAIM 24

A. Turner

421. Turner states:

“This invention relates generally to digital cameras” Turner, [0002];

“The present invention provides methods, systems, and computer-based program products for correcting image streaking, light scattering, and other effects in digital images generated by multispectral sensors.” Turner, [0006], Abstract;

“light scattering effects are removed from the corrected image frame based upon characteristics of the digital sensor” Turner, [0010].

422. Turner thus corrects digital images for scattered light.

B. Claim 24

24	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for scattered light aberrations.
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423. Claim 24 depends from claim 1. Watanabe in view of Turner meets claim 1 because, as described in detail in §IX.B above, Watanabe meets claim 1.

424. POSAs would have had reasons to include Turner’s corrections of scattered light in Watanabe because this would have improved Watanabe’s system, which does not specifically describe correcting light scattering, and extended its image correction capabilities to meet a practical need:

“cameras... cause light scattering that also reduces the radiometric accuracy of an image... Therefore, there exists an unmet need to produce low-cost, radiometrically accurate images.” Turner, [0004]-[0005].

425. POSAs would have found it desirable and practical to add Turner’s corrections of scattered light to the “control program” in Watanabe’s digital image processing system because this is how Watanabe implemented its digital image processing.

426. POSAs would have had a reasonable expectation of success because the programming to implement Turner’s corrections on a digital signal processor was within the POSA’s ordinary skill. This reflects the widespread and well-known use of DSPs controlled by CPUs to perform image data processing:

“The TMS320C8x digital signal processor (DSP) is a single-chip, multiprocessor device for use in image processing” EX1019, SL: 1-1;

“A single ’C8x contains up to five powerful, fully programmable processors: a master processor (MP) and up to four parallel processors (PPs). The MP is a 32-bit RISC (reduced instruction set computer) processor” EX1019, iii.

427. Watanabe in view of Turner thus meets claim 24.

**XV. GROUND 7: WATANABE IN VIEW OF LIEGE RENDERS
OBVIOUS CLAIM 26**

A. Liege

428. Liege describes using information correcting images from frames of digital video for “defects related to the characteristics of the optical system” (e.g., the lens) including astigmatism among many others (*see, e.g.*, Liege, 22:45-23:35), based on previously assembled (“formatted”) information stored in a database describing those defects:

“The object of the application is to improve the quality of images processed by the image-processing software or the image-processing components, by correcting for the effects of at least one of the defects of the appliances of the appliance chain.” Liege, 4:24-28;

“The purpose of the system is to correct or modify the defects introduced by each device of the chain into processing of the image.” Liege, 30:18-20;

“A defect P5 of an appliance of the appliance set P75 is defined as a defect related to the characteristics of the optical system... examples of defects P5 include distortion, blurring, Vignetting, chromatic aberrations, rendering of colors, flash uniformity, sensor noise, grain, astigmatism, spherical aberration” Liege, 9:4-11;

“The said geometric defects include geometric defects of image 103 characterized by the parameters associated with the filming characteristics 74 and a parameterizable transformation representing

the characteristics of image-capture appliance 1 at the moment of filming.” Liege, 22:37-41;

“Image-processing means employ formatted information 15 related to the defects P5 of at least one appliance of appliance chain P3. The formatted information P3 depends on at least one variable.” Liege, 11:4-7;

“Formatted information 15... is defined as... data related to the intrinsic technical characteristics of image-capture appliance 1, especially the distortion characteristics” Liege, 21:59-64;

“The formatted information 15 associated with image 103 can be recorded in several forms and structured into one or more tables, but it corresponds logically to all or part of fields 90, comprising: (a) the focal distance, (b) the depth of field (c) the geometric defects. The said geometric defects include geometric defects of image 103 characterized by the parameters associated with the filming characteristics 74 and a parameterizable transformation representing the characteristics of image-capture appliance 1 at the moment of filming. By means of the said parameters and of the said parameterizable transformation, it is possible to calculate the corrected position of a point of image 103.” Liege, 22:30-44;

“the method additionally includes the stage of storing at least part of the formatted information in advance in a database.” Liege, 2:5-7;

“The database may be integrated into the system or may be at least partly remote.” Liege, 31:55-56;

“the method is such that one of the appliances of the appliance chain is provided with at least one variable characteristic depending on the image, especially the focal length. A fraction of the specific formatted information is related to the defects of the appliance provided with the variable characteristic.” Liege, 2:9-14;

“an organizational diagram employing an image 103, a real restitution projection 90 giving a restituted image 191 of image 103 for the restitution characteristics 95 used, a parameterizable restitution transformation model 97 giving a corrected restitution image 94 of image 103” Liege, 12:22-26.

B. Watanabe in view of Liege

429. Watanabe does not specifically describe correcting astigmatism.

POSAs would have had reasons to use Liege’s astigmatism correction in Watanabe’s system because this would extend Watanabe’s functionality by increasing the number of distortions it corrected.

430. POSAs would have had a reasonable expectation of success because Watanabe already provided image processing components to support Liege’s astigmatism correction, including a database comprising tables associating particular distortion corrections with optical system lenses at different focal length and zoom settings, to which astigmatism corrections would simply add additional tables:

“The formatted information 15 associated with image 103 can be recorded in several forms and structured into one or more tables”
Liege, 22:30-32;

“the method additionally includes the stage of storing at least part of the formatted information in advance in a database.” Liege, 2:5-7;

“A database 22 of characteristics or database 22 is defined as a database containing formatted information 15 for one or more image-capture appliances 1 and for one or more images 103.” Liege, 22:7-10;

“The database may be integrated into the system” Liege, 31:55.

431. Liege discloses performing corrections with software:

“Image-processing software 4 is defined as software that accepts one or more completed images 120 as input and that performs processing operations on these images.” Liege, 25:10-12.

432. POSAs would have understood that adding to Watanabe’s system software machine readable instructions implementing Liege’s astigmatism correction was within the POSA’s ordinary skill.

C. Claim 26

26	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for astigmatism aberrations.
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433. Claim 26 depends from claim 1. Watanabe in view of Liege meets claim 1 because, as described in detail in §IX.B above, Watanabe meets claim 1.

434. As explained in detail in §XV.B above, Watanabe in view of Liege includes machine readable instructions in software to implement Liege's astigmatism correction in images from digital video.

435. The software meets claim 26's "machine readable instructions for the system to correct astigmatism aberrations" requirement.

436. Watanabe in view of Liege this meets claim 26.

XVI. GROUND 8: TAKANE IN VIEW OF WATANABE RENDERS OBVIOUS CLAIMS 1-2, 6-7, 10, 12, 14, 15, 17-18, 27-28, AND 30

A. Takane

437. As described in detail in §XII.A above, Takane describes a digital imaging system that captures video and provides image processing that corrects distortion.

438. Takane describes: "a digital camera 10 relating to the present embodiment is structured to include... an external ROM 22 in which various programs, parameters, conversion tables and the like are stored in advance" (Takane [0033], Figs. 1, 2)

439. Takane states:

"Parameters expressing a polynomial which approximates the amount of displacement of the optical distortion (i.e., the coefficients of a polynomial) are stored in advance in each of the first distortion correction circuit 56 and the second distortion correction circuit 58. By using these parameters, the first distortion correction circuit 56 and

the second distortion correction circuit 58 correct the optical distortion included in the inputted digital image data.” Takane, [0054];

“in order to handle different focal lengths such as the telephoto end and the wide-angle end and the like, JP-A No. 11-275391 discloses storing parameters for each focal length, and carrying out correction by selecting the parameters in accordance with the focal length at the time of photographing.” Takane, [0008];

“the digital camera 10 of the present embodiment has an optical zoom function. Thus, parameters which are peculiar to the predetermined image size obtained at the time of photographing standby or at the time of dynamic image photographing (the VGA size in the present embodiment) can be stored for each of a plurality of predetermined focal distances. The group of optimal parameters can be selected in accordance with the focal length at the time of obtaining the digital image data which is the object of correction, and processing for correcting the optical distortion can be carried out.” Takane, [0060].

440. Takane does not explain how it stores correction parameters in ROM 22 or distortion circuits 56 and 58, how the system loads correction parameters into circuits 56 and 58, or how the system changes the correction parameters in the distortion correction circuits to match the aberration(s) for different optical system components (lenses) and their settings or parameters (focal length or zoom position).

B. Takane in view of Watanabe

441. Takane shows as well known:

Takane, [0008] (“in order to handle different focal lengths such as the telephoto end and the wide-angle end and the like, JP-A No. 11-275391 discloses storing parameters for each focal length, and carrying out correction by selecting the parameters in accordance with the focal length at the time of photographing.”).

442. However, Takane leaves the camera’s data storage and retrieval techniques to the implementer.

443. Watanabe discloses storing optical distortion correction parameters by a lens, focal length, and zoom position in tables as explained in detail in §§IX.B.2 ([1.a]), IX.B.4 ([1.d]) above. Watanabe’s tables comprise a database as explained in detail in §IX.B.2.e above regarding [1.a].

444. As explained in detail in §IX.B.2.e above, Watanabe’s control program retrieves image correction data associated with lens-specific focusing points and zoom positions from the database (tables 70, table 20), thus comprising a DBMS, and Watanabe’s software provides the distortion correction parameters to the DSP to correct image distortions.

445. As described in detail in §IX.B.2.e above, Watanabe’s database and DBMS teachings were well known. POSAs would have had several reasons to use those teachings in order to implement Takane’s system by organizing distortion

correction parameters by image size, lens, focal length, and zoom position in tables comprising a database, then identifying and retrieving parameters, and providing them to Takane's distortion correction circuits to correct distortion, because Watanabe demonstrates these techniques were conventional.

446. POSAs would have known that Watanabe's database techniques would provide for storing in tables in a database Takane's description of correction parameters for each focal length (Takane, [0008]) and for accessing tables from the database to select correction parameters based on focal length at the time of image capture (Takane, [0060]).

447. Takane expresses concern that if the correction amounts are stored as numerical values per pixel, the resulting tables storing those correction amounts would be large ([0007]) and suggests instead "expressing the correction amounts by an approximate expression" in which case "correction can be set in correspondence by computation" (Takane [0008]).

448. A POSA would choose one or the other approach to storing correction amounts based on practical consideration of the cost of memory versus the cost of additional computing power.

449. Using Watanabe's database and DBMS teaching was within the POSA's ordinary skill and would have improved Takane in the same way it improved Watanabe (as explained in detail in §IX.B.2.e above).

450. POSAs would have had a reasonable expectation of success because, as described in detail in §IX.B.2.e above, Watanabe demonstrates that storing correction parameters in a database and DBMS software retrieving parameters from the database were conventional.

451. Thus in Takane in view of Watanabe, Takane's system uses Watanabe's tables (database) to organize and store parameters for optical distortion correction for each image size, lens, focal length, and zoom position in Takane's ROM 22.

452. Takane describes its software:

“a control routine (a main routine) executed at a CPU of the digital camera” Takane, [0028];

“dynamic image photographing processing (a sub-routine) executed at the CPU of the digital camera” Takane, [0030].

453. Takane's software then uses Watanabe's teaching to retrieve parameters from the database and loads them into the distortion correction circuits based on the image size, lens, focal length, and zoom position at the time of image capture:

“Parameters expressing a polynomial which approximates the amount of displacement of the optical distortion (i.e., the coefficients of a polynomial) are stored in advance in each of the first distortion correction circuit 56 and the second distortion correction circuit 58.

By using these parameters, the first distortion correction circuit 56 and the second distortion correction circuit 58 correct the optical distortion included in the inputted digital image data.” Takane, [0054];

“The group of optimal parameters can be selected in accordance with the focal length at the time of obtaining the digital image data which is the object of correction, and processing for correcting the optical distortion can be carried out.” Takane, [0060].

C. Claim 1

454. Claim 1 can be parsed as follows:

1.PRE	A digital imaging system for correcting optical image aberrations in a digital video, comprising:
1.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing the digital video, an integrated circuit including; a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
1.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
1.c	wherein the integrated circuit uses the in-camera software to identify at least one optical image aberration and
1.d	to correct the at least one optical image aberration in at least one frame of the digital video using at least one of the plurality of optical image aberration corrections in the database;
1.e	wherein the video is captured by the at least one digital sensor and is forwarded to the digital signal processor;
1.f	wherein the video image file with the at least one optical image aberration is corrected by applying digital filtration using the digital signal processor; and
1.g	wherein the corrected video consisting of the digital data optimized from the at least one optical image aberration that are corrected from the original video image is stored in the memory storage sub-system.

1. Limitation [1.PRE]

1.PRE	A digital imaging system for correcting optical image aberrations in a digital video, comprising:
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455. As described in §XII.A above, Takane describes a digital photographing device that corrects optical distortion by digital signal processing on images captured by “dynamic image photographing in which continuous results of photographing by the CCD... are outputted.” Takane, [0041], [0006], [0011], [0014], [0017], and Takane’s “dynamic image photographing” means digital video.

456. Takane corrects optical image aberrations in a digital video as explained in detail in §XII.C.3 above.

457. Takane in view of Watanabe thus meets [1.PRE].

2. Limitation [1.a]

1.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing the digital video, an integrated circuit including; a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
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458. Takane in view of Watanabe meets [1.a] as shown below.

a. “digital video camera including in-camera software”

459. As described in detail in §XII.A above, Takane describes a “digital photographing device” that includes a “digital video camera.” Takane, [0006], [0015], [0041]-[0042].

460. The digital video camera captures video in a “dynamic image photographing mode” (Takane, [0015], [0034], [0041], [0070], [0074], [0100], [0101]) using “continuous photographing by the CCD” (Takane, [0102]), [0105]).

461. Takane’s digital camera includes external ROM 22 that stores “programs... in advance[.]” Takane, [0033].

462. Takane’s device executes a “control routine” that includes dynamic image (video) processing. Takane, [0028], [0030], [0073], [0100]-[0111], Fig. 3 (step 106), Fig. 5.

463. The stored programs and the routines that Takane’s camera executes are “in-camera software” because they execute in the camera:

“FIG. 3 is a flowchart showing a control routine (a main routine) executed at a CPU of the digital camera” Takane, [0028];

“FIG. 5 is a flowchart showing dynamic image photographing processing (a sub-routine) executed at the CPU of the digital camera” Takane, [0030];

“[A] digital camera 10 relating to the present embodiment is structured to include a main controlling section 24 governing the overall operation of the digital camera 10.” Takane, [0033];

“[T]he main controlling section 24 is structured [to include] a computing section 44 which carries out control computation of the entire main controlling section 24. The computing section 44 is structured to include an image processing circuit 46 which carries out

predetermined processings on an inputted digital signal and generates digital image data, and a CPU 48 serving as a control section which governs control of the main controlling section 24.” Takane, [0035].

464. Takane in view of Watanabe thus meets [1.a].

b. “digital sensor for capturing the digital video”

465. The ’685 specification identifies “CCD” as a “digital sensor[]” in which “photons are recorded by electrically charged pixels.” EX1001, 14:17-26. Takane captures “dynamic images” (e.g., video) using a CCD, which it digitizes to provide digital image data. Takane, [0033], [0035], [0039], [0041]-[0042], [0044], Fig. 1 (CCD 14, A/D 30).

466. Takane in view of Watanabe thus has the required “digital sensor for capturing the digital video.”

c. “optical lens mechanism”

467. As described in detail in §IX.B.2.c above, the “optical lens mechanism” of limitation [1.a] is some form of lens.

468. Takane describes an “optical unit 12” that “is structured as a zoom lens whose focal length can be changed[.]” Takane, [0038].

469. Takane in view of Watanabe thus has the required “optical lens mechanism.”

d. “integrated circuit including a digital signal processor”

470. The '685 Patent does not provide, either in the specification or the claims, any description of the claimed “digital signal processor” other than as a name for a body of functional capability assigned to carry out certain processes on digital data. As I understand the '685 Patent, anything which performs the process assigned to the claimed “digital signal processor” can meet this limitation.

471. Takane states:

“[T]he main controlling section 24 [includes] a computing section 44 which carries out control computation of the entire main controlling section 24. The computing section 44 is structured to include an image processing circuit 46 which carries out predetermined processings on an inputted digital signal and generates digital image data, and a CPU 48 serving as a control section which governs control of the main controlling section 24.” Takane [0035];

“the image processing circuit 46 is structured to include a signal processing circuit 50... a dynamic image signal processing circuit 52... a still image signal processing circuit 54... and a first distortion correction circuit 56 and a second distortion correction circuit [58]” Takane, [0043].

472. All Takane’s “processing circuit[s]” and “correction circuit[s]” listed above process a “digital signal” representing an image and treated as “digital image data”:

“[T]he image signal, which expresses the subject obtained by the CCD 14 at the time of photographing, is converted from an analog signal into a digital signal, the digital signal is inputted to the image processing circuit 46 and is treated as digital image data.” Takane, [0042].

473. All Takane’s “processing circuit[s]” and “correction circuit[s]” thus process digital signals, and so could be regarded as “digital signal processors.”

474. Takane does not describe how distortion correction circuits 56 or 58 are implemented, leaving that to the POSA, but does place at least the aforementioned processors and the aforementioned CPU on a single integrated circuit:

“the main controlling section 24 is structured as a one-chip LSI (large scale integrated circuit)” Takane, [0036].

475. Semiconductor devices called “digital signal processors” or “DSPs” which include a CPU on the same chip are general-purpose devices which are directed to carry out a certain process on a digital signal by programming specific to that process.

476. POSAs would have had reasons to use such an integrated DSP-plus-CPU on a chip to implement circuits 50, 52, 54, 56, and 58, with a reasonable expectation of success, because such DSPs were designed and routinely used for digital signal processing, including image processing:

“The TMS320C8x digital signal processor (DSP) is a single-chip, multiprocessor device for use in image processing...” EX1019, SL: 1-1;

“The TMS320C8x architecture combines RISC processing and the processing power of multiple advanced DSPs (parallel processors).” EX1019, SL: 2-1;

“The following information describes each functional unit of the TMS320C8x:

- Master processor (MP). The MP [highlighted green in figure 2-1 below] is a 32-bit RISC processor with an IEEE-754 floating-point unit (FPU)
- Parallel processors (PPs). The PPs [all four highlighted blue in figure 2-1 below] are advanced DSP, 32-bit integer units.” EX1019, SL: 2-3;

Figure 2-1. TMS320C80 Block Diagram

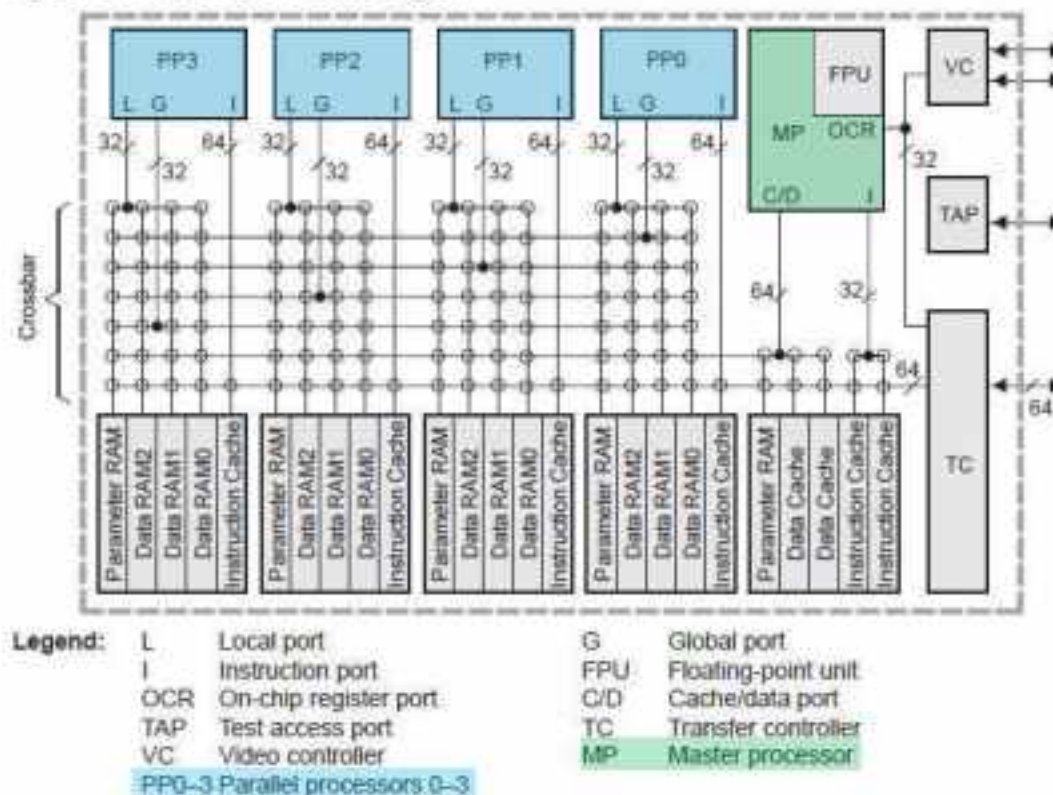


Figure 2-1, with color annotations added. EX1019, SL: 2-2.

477. This master processor (MP) is a specific kind of CPU.

478. Computers, both general and special purpose, contain processors (often called “central processing units” or “CPUs”) which can carry out mathematical and logical operations defined in their structures as “instructions” which can be called for by programs provided to and executed by the CPUs.

479. Many dedicated CPUs, as found in digital cameras, need only a modest set of instructions to carry out the kinds of programs they’ll be asked to run. Such processors can be called “RISC” (for “Reduced Instruction Set Computer”) processors because their instruction sets are “reduced” compared to

the larger instruction sets of a general purpose processor as found in a Windows or Macintosh computer.

480. POSAs would understand that the programmability of DSPs and their support processors would simplify implementation of additional corrections and other functions, whether part of the continuous image processing stream or asynchronous:

“A single 'C8x contains up to five powerful, fully programmable processors: a master processor (MP) and up to four parallel processors (PPs). The MP is a 32-bit RISC (reduced instruction set computer) processor with an integral, high-performance IEEE-754 floating-point unit. Each PP is a 32-bit advanced DSP that combines capabilities similar to those of conventional DSPs with advanced features to accelerate operation on a variety of data types.” EX1019, iii;

“Software tools allow you to write programs in C and assembly language for the MP and PPs.” EX1019, SL: 1-2;

“The 'C8x... readily adapts to the computational requirements of proprietary algorithms by combining exceptional processing speed with full programmability” EX1019, SL: 1-6;

“The 'C8x generation offers multiprocessing capabilities.” EX1019, SL: 1-3.

481. Thus, Takane’s “one-chip LSI (large scale integrated circuit)” carrying control section 24 including one or more DSPs implementing at least the

first distortion correction circuit 56 and the second distortion correction circuit 58 provides Takane in view of Watanabe the “digital signal processor” required by limitation [1.a].

e. “integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections”

482. As described in detail in §XVI.C.2.d above, Takane discloses an integrated circuit including a digital signal processor and CPU.

483. As described in detail in §XVI.B above, in Takane in view of Watanabe, Takane’s integrated circuit executes software that accesses a database comprising tables with correction parameters that it provides to the DSP comprising distortion correction circuit 56.

484. As described in detail in §IX.B.2.e above, the software accessing the database is a database management system.

485. As discussed in detail in §XVI.B above, Takane in view of Watanabe’s database contains parameters for correcting optical distortion aberration for many different lenses and lens settings.

486. Thus, Takane in view of Watanabe provides an “integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections.”

f. “memory storage sub-system”

487. Takane describes:

“an image data temporarily storing section 20 such as an SRAM or an SDRAM or the like, for temporarily storing the digital image data obtained by photographing by the CCD” Takane, [0033];

“The digital image data, which has been subjected to optical distortion correcting processing in the first distortion correction circuit 56 or the second distortion correction circuit 58, is transmitted to the memory control circuit 36 via the bus 60, and, under the control of the memory control circuit 36, is temporarily stored in the image data temporarily storing section 20.” Takane, [0065];

“the corrected digital image data which has been stored in the image data temporarily storing section 20 in this way, is read by the memory control circuit 36, is transmitted to the compression/decompression circuit 38 via the bus 60, and is compressed in a predetermined compression format (e.g., JPEG) by the compression/decompression circuit 38. Thereafter, the data can be transmitted to the media control circuit 42 via the bus 60, and can be stored in the external recording medium 72 by the media control circuit 42.” Takane, [0066].

488. A POSA would recognize the ensemble of these components as the required “a memory storage sub-system.”

g. Limitation [1.b]

1.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
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489. Takane in view of Watanabe meets [1.b] because Takane describes a zoom lens:

“The optical unit 12 is structured as a zoom lens whose focal length can be changed (whose magnification can be changed).” Takane, [0038].

3. Limitations [1.c] and [1.d]

1.c	wherein the integrated circuit uses the in-camera software to identify at least one optical image aberration and
1.d	to correct the at least one optical image aberration in at least one frame of the digital video using at least one of the plurality of optical image aberration corrections in the database;

490. As explained in detail in §XVI.C.2.d above, Takane provides the required integrated circuit including CPU and digital signal processor.

491. That digital signal processor includes “correction sections correcting optical distortion included in the digital image data” (Takane, 0015) for which “conversion tables and the like are stored in advance” (Takane, 0033)).

492. As explained in detail in §XVI.B above, these tables contain “parameters which are peculiar to the predetermined image size... at the time of dynamic image photographing” that have been “stored for each of a plurality of predetermined focal distances.” Takane, [0060].

493. As explained in detail in §XVI.C.2.a, that integrated circuit contains the in-camera software which “carries out predetermined processings performing video image processing.” Takane, [0035].

494. A POSA would understand that “carr[ying] out predetermined processings” for “correcting optical distortion” aberration is done in Takane by having the in-camera software identify in the database the proper “conversion table[]” for the specific aberration, which could be the “pin-cushion” or “barrel” distortion that Takane describes as known to be correctable with its method for the lens and focal length at video capture:

“Such distortion is generally called optical distortion, and is classified into the following two types: ‘pin-cushion distortion’ in which the corner portions of the image extend outwardly, and ‘barrel distortion’ in which, conversely, the corner portions contract.” Takane, [0005];

“a digital photographing device in which the processing time for correcting optical distortion can be shortened.” Takane, [0014];

“various programs, parameters, conversion tables and the like are stored in advance” Takane, [0033];

“parameters which are peculiar to the predetermined image size obtained at the time of photographing standby or at the time of dynamic image photographing (the VGA size in the present embodiment) can be stored for each of a plurality of predetermined focal distances. The group of optimal parameters can be selected in accordance with the focal length at the time of obtaining the digital image data which is the object of correction, and processing for correcting the optical distortion can be carried out.” Takane, [0060].

495. Takane in view of Watanabe thus meets [1.c] because Takane's integrated circuit uses the in-camera software to identify at least one optical image aberration.

496. Takane's image processing circuit 46, and first distortion correction circuit 56, "carries out predetermined digital signal processing" and corrects optical distortion on dynamic images, and thus on successive frames and "at least one frame" of the digital video comprising "dynamic images:"

"a signal processing circuit 50 which, regardless of whether the image is a still image or dynamic images, carries out predetermined digital signal processings on the inputted digital image data" Takane, [0043]

"if the photographing mode selected by the photographer operating the mode switching switch 18B is the dynamic image photographing mode, the routine proceeds from step 100 in FIG. 3 to step 102 and step 106, and the sequence processings (dynamic image photographing processing), which are for photographing dynamic images and are shown in FIG. 5, are carried out... correction processing is carried out by the first distortion correction circuit 56 such that the optical distortion in the horizontal direction is corrected." Takane, [0100]-[0102]

497. Takane in view of Watanabe uses Watanabe's teaching of using multiple lenses with an imaging system. Takane stores correction parameters "in advance" in first distortion correction circuit 56 based on the lens and focal length,

then corrects optical distortion in digital video using the correction parameters. Takane, [0054]. These correction parameters are “stored” for either the “pin-cushion” or “barrel” distortion aberrations that Takane describes as known to be correctable with its method (Takane, [0005], [0054]-[0059]) and for each of a plurality of predetermined focal distances and the lens and focal length at video capture.” Takane, [0060].

498. This meets [1.d].

4. Limitation [1.e]

1.e	wherein the video is captured by the at least one digital sensor and is forwarded to the digital signal processor;
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499. Takane in view of Watanabe meets [1.e] because Takane’s CCD captures “dynamic images” (video). Takane, [0041].

500. Takane’s A/D converter digitizes the video at the CCD output and sends it to signal processing circuit 50, dynamic image signal processing circuit 52, and first distortion correction circuit 56, all of which are, as described in detail in §XVI.C.2.d above, are digital signal processors:

“At the image processing circuit 46, the digital image data from the A/D converter 30 is first inputted to the signal processing circuit 50.” Takane, [0044];

“The output end of the signal processing circuit 50 is connected to the dynamic image signal processing circuit 52 and the still image signal processing circuit 54.” Takane, [0045];

“The digital image data, which has been processed by the dynamic image signal processing circuit 52 or the still image signal processing circuit 54, is inputted via the bus 60 to the first distortion correction circuit 56 or the second distortion correction circuit 56.” Takane, [0053].

501. This meets [1.e].

5. Limitation [1.f]

502. Takane in view of Watanabe meets [1.f] because Takane’s first distortion correction circuit 56 comprising a DSP (per §XVI.C.2.d above) corrects optical distortion in the image data using the polynomial parameters relating to distortion based on the lens and focal length. Takane, [0054]-[0062], [0100]-[0102]; §XVI.A above.

503. Takane describes determining the image before correction using nearest-neighbor or bi-linear interpolation and a multidimensional function parameterized by the coefficients associated with the lens focal length (Takane, [0055]-[0057]), then correcting optical distortion by “making the pixel data... into pixel data of the coordinates (x, y) in the image after correction.” Takane, [0058].

504. This process applies “digital filtration” for correction as explained in detail in §IX.B.6.a.(1) above.

505. This meets [1.f].

6. Limitation [1.g]

1.g	wherein the corrected video consisting of the digital data optimized from the at least one optical image aberration that are corrected from the original video image is stored in the memory storage sub-system.
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506. Takane in view of Watanabe meets [1.g] because, as described in detail in §XVI.C.2.f above, Takane discloses storing corrected image data in the claimed memory storage sub-system.

D. Claim 2

507. Claim 2 can be parsed as follows:

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

508. Takane in view of Watanabe meets [2.PRE] because Claim 2 depends from Claim 1, which is met by Takane in view of Watanabe (per §XVI.C above).

509. Takane in view of Watanabe meets [2.a] because Takane describes pin-cushion and barrel distortions as types of optical distortion:

“In a photographing device which photographs a subject through an optical lens and acquires an image which shows the subject, distortion arises at the periphery of the acquired image due to refraction of the lens. Such distortion is generally called optical distortion, and is classified into the following two types: ‘pin-cushion distortion’ in which the corner portions of the image extend outwardly, and ‘barrel

distortion' in which, conversely, the corner portions contract.”
Takane, [0005].

510. Takane corrects optical distortion in the camera:

“the digital photographing device comprising: a plurality of correction sections correcting optical distortion included in the digital image data” Takane, [0015];

“it is preferable that the correction sections approximate the optical distortion by a polynomial, and correct the optical distortion by interpolating each pixel after correction from digital image data before correction.” Takane, [0025].

511. POSAs would have understood that Takane’s optical distortion correction applies to pin-cushion and barrel distortions.

512. Takane in view of Watanabe thus meets Claim 2.

E. Claim 6

513. Claim 6 can be parsed as follows:

6.PRE	A digital imaging system for correcting image aberrations comprising:
6.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
6.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
6.c	wherein the video is forwarded to storage in memory;
6.d	wherein at least one optical aberration in at least two frames of the digital video are identified using the in-camera software and the integrated circuit;

6.e	wherein the at least one optical aberration from the optical lens mechanism of at least two frames of the digital video are corrected by using the digital signal processor to apply at least one digital filtration algorithm; and
6.f	wherein the corrected digital video file is stored in memory.

1. Limitations [6.PRE], [6.a], [6.b], and [6.f]

6.PRE	A digital imaging system for correcting image aberrations comprising:
6.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
6.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
6.f	wherein the corrected digital video file is stored in memory.

514. Takane in view of Watanabe meets [6.PRE], [6.a], [6.b], and [6.f] for the same reasons it meets the corresponding limitations in claim 1:

Limitation	Corresponding Limitation	Detailed Discussion
[6.PRE]	[1.PRE]	§IX.B.1
[6.a]	[1.a]	§IX.B.2
[6.b]	[1.b]	§IX.B.3
[6.f]	[1.g]	§IX.B.7

515. While “corrected video file” in limitation [6.f] has no antecedent basis in claim 6, Takane discloses saving corrected video in memory as explained for limitation [1.g].

2. Limitation [6.c]

6.c	wherein the video is forwarded to storage in memory;
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516. Takane in view of Watanabe meets [6.c] because Takane describes “an image data temporarily storing section 20 such as an SRAM or SDRAM or the like, for temporarily storing the digital image data obtained by photographing by the CCD 14[.]” Takane, [0033].

3. Limitation [6.d]

6.d	wherein at least one optical aberration in at least two frames of the digital video are identified using the in-camera software and the integrated circuit;
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517. Takane in view of Watanabe meets [6.d] because, as described in detail in §XVI.C.2.a above, the combination uses Takane’s software (“in-camera software”) to select “parameters which are peculiar to the predetermined image size” for a lens and focal length at image capture to correct optical distortion. Takane, [0060], [0101].

518. As described in detail in §XVI.C.4 above, the parameters associated with image capture “identif[y]” the optical aberration in the video.

519. Takane describes making the corrections in “the sequence processings (dynamic image photographing processing)” (Takane, [0100]), meaning Takane applies distortion correction to successive frames (e.g., “at least two frames”) of video.

520. This meets [6.d].

4. Limitation [6.e]

6.e	wherein the at least one optical aberration from the optical lens mechanism of at least two frames of the digital video are corrected by using the digital signal processor to apply at least one digital filtration algorithm; and
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521. Takane in view of Watanabe meets [6.e] because Takane's first distortion circuit 56 is a DSP that uses the parameters identified in [6.d] and an interpolation algorithm to correct optical distortion in successive frames of digital video:

“Parameters expressing a polynomial which approximates the amount of displacement of the optical distortion (i.e., the coefficients of a polynomial) are stored in advance in each of the first distortion correction circuit 56 and the second distortion correction circuit 58. By using these parameters, the first distortion correction circuit 56 and the second distortion correction circuit 58 correct the optical distortion included in the inputted digital image data.” Takane, [0054];

“in order to decrease the memory capacity required for correction by the correction sections, it is preferable that the correction sections approximate the optical distortion by a polynomial, and correct the optical distortion by interpolating each pixel after correction from digital image data before correction.” Takane, [0025];

“optical distortion can be corrected by making the pixel data, which is determined by interpolation in accordance with an interpolation method such as nearest neighbor interpolation, bi-linear interpolation,

or the like, into pixel data of the coordinates (x,y) in the image after correction.” Takane, [0058].

522. Takane’s distortion correction and interpolation scheme (Takane, [0055]-[0058]) is a form of the claimed “digital filtration algorithm” for the same reasons, described in detail in §IX.E.4 above, that Watanabe’s correction process is.

F. Claim 7

523. Claim 7 can be parsed as follows:

7.PRE	The system of claim 6:
7.a	wherein the optical image aberrations include spherical, comatic, lens distortion, astigmatism, chromatic aberrations, curvature of field, pin cushion, barrel distortion, scattered light, and/or flare types of optical aberrations.

524. Takane in view of Watanabe meets [7.PRE] for the same reasons it meets claim 6 (per §IX.E above).

525. Takane in view of Watanabe meets [7.a] for the same reasons it meets [2.a] (per §IX.C above).

G. Claim 10

526. Claim 10 can be parsed as follows:

10.PRE	The system of claim 6:
10.a	wherein the digital signal processor applies color filtration to at least two frames of the digital video image.

527. Takane in view of Watanabe meets [10.PRE] because it meets claim 6 (per §XVI.E above).

528. Takane in view of Watanabe meets [10.a] because, as described in detail in §XII.C.2 above, Takane describes signal processing circuit 50, which is a digital signal processor (per §XVI.2.d above), making white balance adjustment. Takane, [0044].

529. Takane's white balance adjustment is color filtration as described in detail in §XII.C.2 above.

530. Takane applies white balance to "at least two frames" of digital video because it corrects successive frames in "dynamic images," which are video. Takane, [0043]-[0044]; §VII.A.2 above.

H. Claim 12

531. Claim 12 can be parsed as follows:

12.PRE	The system of claim 6:
12.a	wherein the integrated circuit may be a microprocessor, an application specific integrated circuit or a system on a chip.

532. Takane in view of Watanabe meets [12.PRE] because it meets claim 6 (per §XVI.E above).

533. Takane in view of Watanabe meets [12.a] because "main controlling section 24 is structured as a one-chip... large scale integrated circuit." Takane, [0036]; §XVI.C.2.d above.

534. POSAs would have recognized Takane's main controlling section 24 as a system on chip ("SoC"), meeting [12.a], because it combined different types

of processors (CPU and DSP) in a single IC, connected by a bus 60, and the component integration made Takane's system "compact, reliable, and inexpensive:"

"the main controlling section 24 is structured as a one-chip LSI (large scale integrated circuit). The digital camera 10 can thereby be made compact, reliable, and inexpensive." Takane, [0036].

I. Claim 14

535. Claim 14 can be parsed as follows:

14.PRE	A digital imaging system for correcting image aberrations comprising:
14.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
14.b	wherein the optical lens mechanism is a zoom lens;
14.c	wherein the zoom lens changes focal length positions;
14.d	wherein when the digital video is forwarded to the digital signal processor and to memory;
14.e	wherein the integrated circuit uses system software to access the database to identify at least one optical aberration in at least one frame of the video at any focal length of a zoom lens configuration;
14.f	wherein the integrated circuit accesses the database to obtain at least one filtration correction algorithm to the optical image aberration of at least one frame in the video file and forwards the at least one filtration algorithms to the digital signal processor;
14.g	wherein the digital video is forwarded to the digital signal processor which applies at least one filtration algorithm to optimize the digital video and corrects the at least one optical image aberration in at least one video frame for the at least one focal length in the zoom lens configuration; and
14.h	wherein the corrected digital video is stored in memory.

1. Limitations [14.PRE], [14.a], [14.b], and [14.h]

14.PRE	A digital imaging system for correcting image aberrations comprising:
14.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
14.b	wherein the optical lens mechanism is a zoom lens;
14.h	wherein the corrected digital video is stored in memory.

536. Takane in view of Watanabe meets the following claim 14 limitations for the same reasons it meets the corresponding limitations in claim 1:

Limitation	Corresponding Limitation	Discussion
[14.PRE]	[1.PRE]	§XVI.C.1
[14.a]	[1.a]	§IX.B.2
[14.b]	[1.b]	§IX.B.3
[14.h]	[1.g]	§XVI.C.6

2. Limitation [14.c]

14.c	wherein the zoom lens changes focal length positions;
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537. Takane in view of Watanabe meets [14.c] because Takane's "optical unit 12 is structured as a zoom lens whose focal length can be changed[.]" Takane, [0038]; §IX.I.2 above.

3. Limitation [14.d]

14.d	wherein when the digital video is forwarded to the digital signal processor and to memory;
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538. Takane in view of Watanabe meets [14.d] because, as described in detail in §XVI.C.4 above, Takane forwards digitized video from the A/D converter

to image processing circuit 46 and the DSP comprising signal processing circuit 50, dynamic image signal processing circuit 52, and first distortion correction circuit 56.

539. As explained in detail in §XVI.E.2 above, Takane forwards the digital video to memory. Takane, [0033].

4. Limitation [14.e]

14.e	wherein the integrated circuit uses system software to access the database to identify at least one optical aberration in at least one frame of the video at any focal length of a zoom lens configuration;
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540. Takane in view of Watanabe meets [14.e] because the combination uses Takane's integrated circuit to execute Watanabe's modified software to retrieve correction parameters from the database based on, among other things, the lens and focal length of the zoom lens used at the time of image capture.

§§XVI.E.3, XVI.B above.

541. Takane describes correcting distortions in “dynamic images” that are video comprising successive images, and thus identifies corrections “in at least one frame of the video” based on the zoom lens focal length at image capture.”

Takane, [0038]; §XVI.C.2.a, XVI.I.2 above.

5. Limitation [14.f]

14.f	wherein the integrated circuit accesses the database to obtain at least one filtration correction algorithm to the optical image aberration of at least one frame in the video file and forwards the at least one filtration algorithms to the digital signal processor;
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542. The “video file” in [14.f] has no antecedent basis in claim 14. §IX.I.5 above.

543. POSAs would have understood that Takane in view of Watanabe was capable of applying corrections to a frame in a video file because Takane describes correcting distortions in “dynamic images” that are video comprising successive images as described in §XVI.C.2.a ([1.a]) above.

544. Takane’s DSP uses multi-dimensional function(s) $F(d)$ with parameters “stored in advance” to determine “displacement of the optical distortion:

“Parameters expressing a polynomial which approximates the amount of displacement of the optical distortion (i.e., the coefficients of a polynomial) are stored in advance in each of the first distortion correction circuit 56 and the second distortion correction circuit 58. By using these parameters, the first distortion correction circuit 56 and the second distortion correction circuit 58 correct the optical distortion included in the inputted digital image data.” Takane, [0054];

“Specifically, the amount of displacement of the optical distortion can be approximately expressed by a multidimensional function $F(d)$ of a distance d from the center of the image (the optical center).” Takane, [0055].

545. Takane does not explain where it stores $F(d)$, leaving this detail to a POSA. A POSA would have understood that there were two known alternatives:

(1) storing the algorithm(s) implementing the function $F(d)$ for a particular lens as executable code in the DSP if the DSP is capable of and has capacity for that non-volatile storage, or (2) storing them in some other memory or computer-readable medium and loading them into the DSP as needed. The first of these could work for a basic camera, while the second permits a camera to correct images in a wider range of settings and circumstances.

546. As discussed in detail above at §§IX.B.2.d and XVI.C.2.d concerning the Texas Instruments SoCs containing CPUs and DSPs, it was known to select and load algorithms from memory to provide particular signal processing (“filtration”) at the DSP.

547. In Takane+Watanabe, a POSA would have understood to store, or at least identify, the DSP filtration algorithm for a particular aberration correction in Watanabe’s database to retrieve and apply the stored parameters (e.g., as memory offsets or look-up addresses in the algorithm database).

548. Thus, Takane’s SoC would “obtain” the correction algorithm by accessing the database for information identifying the algorithm (or the algorithm itself), then “forward” the algorithm to the DSP so it could apply the filter and correct the aberration.

549. As discussed above (regarding option (2)), the retrieval option frees the DSP from having to store every aberration correction algorithm used by the system in advance by loading them on an as-needed basis.

550. Takane in view of Watanabe meets [14.f] because in the combination Takane's main controlling section 24, the integrated circuit (per §XVI.C.2.d above), uses in-camera software (per §XVI.C.2.a above) to access a database to obtain correction parameters associated with the lens and focal length at the time of image capture, which the integrated circuit provides to the distortion correction circuit. §§XVI.B, XVI.C.2.e above; Takane, [0054]-[0062], [0100]-[0102].

551. The correction parameters "express[] a polynomial which approximates the amount of displacement of the optical distortion." Takane, [0054]. Constructing this polynomial for each image size and focal length is an algorithm, as is digital filtration that uses that polynomial to interpolate pixel positions and correct distortion. Takane, [0054]-[0060].

552. Providing the parameters thus provides and enables a filtration algorithm.

6. Limitation [14.g]

14.g	wherein the digital video is forwarded to the digital signal processor which applies at least one filtration algorithm to optimize the digital video and corrects the at least one optical image aberration in at least one video frame for the at least one focal length in the zoom lens configuration; and
------	---

553. Takane in view of Watanabe meets [14.g] because Takane forwards digital video to a first distortion correction circuit that comprises a DSP as explained as explained in §§XVI.C.5, XVI.I.3 above.

554. The distortion correction circuit corrects optical aberrations (including at least pin-cushion and barrel distortions) in digital video based on parameters associated with Takane's zoom lens and focal length when the image was taken. §§XVI.B, XVI.C.4, XVI.C.6; Takane, [0054]-[0062], [0100]-[0102].

555. This corrects aberrations in "at least one video frame."

J. Claim 15

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

556. Takane in view of Watanabe meets [15.PRE] because it meets claim 14 (per §XVI.I above) and it meets [15.a] for the same reasons it meets claim 2 (per §IX.C above).

K. Claim 17

17.PRE	The system of claim 14:
17.a	wherein each focal length of a zoom lens in at least one video image frame is analyzed for a different set of optical aberrations.

557. Takane in view of Watanabe meets [17.PRE] because it meets claim 14 (per §XVI.I above) and it meets [17.a] because Takane uses a zoom lens (per

§XVI.C.2.c above) and Takane in view of Watanabe stores correction parameters for each lens focal length. Takane, [0008], [0038]-[0039], [0060], [0064]; §XVI.B above.

L. Claim 18

18.PRE	The system of claim 14:
18.a	wherein the digital signal processor applies color filtration to at least one frame of the digital video image.

558. Takane in view of Watanabe meets [18.PRE] because it meets claim 14 (per §XVI.I above) and it meets [18.a] for the same reasons it meets [10.a] (per §XVI.G above).

M. Claims 27-28 and 30

27	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for lens distortion aberrations.
28	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for pin cushion aberrations.
30	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for barrel distortion aberrations.

559. Takane in view of Watanabe meets claims 27, 28 and 30 because it meets claim 1 (per §XVI.C above), and because Takane's distortion correction technique applies to its description of pin-cushion distortion (claim 28) and barrel distortion (claim 30) as described in detail for claim 2 in §XVI.D above.

560. As described in detail in §XII.A above, Takane describes pin-cushion and barrel distortion as specific types of distortion "due to refraction of the lens," e.g., "lens distortion" (claim 27). Takane, [0005].

561. As described in detail in §XVI.C.2.a above, Takane's distortion correction is implemented using software (e.g., "machine readable instructions") stored in ROM 22.

XVII. CONCLUSION

562. It is my opinion that based on the POSA's ordinary level of skill, the scope and content of the prior art, and the differences between the Challenged Claims and the prior art teachings, a POSA would have found the subject matter of claims 1-19 and 22-30 to be well-known and obvious for the reasons explained in the Grounds discussed in this Declaration.

563. I have reached the opinions expressed in this Declaration based on my knowledge, education, experience, and expertise, which enable me to speak to what a POSA would have understood at the relevant time of invention.

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

I declare under penalty of perjury that the foregoing is true and correct.

Dated: 16 May 2024

A handwritten signature in black ink, appearing to read 'LL', written over a horizontal line.

Leonard Laub

APPENDIX A: U.S. PATENT NO. 10,873,685 CLAIM LIST

Ref	Limitation
1.PRE	A digital imaging system for correcting optical image aberrations in a digital video, comprising:
1.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing the digital video, an integrated circuit including; a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
1.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
1.c	wherein the integrated circuit uses the in-camera software to identify at least one optical image aberration and
1.d	to correct the at least one optical image aberration in at least one frame of the digital video using at least one of the plurality of optical image aberration corrections in the database;
1.e	wherein the video is captured by the at least one digital sensor and is forwarded to the digital signal processor;
1.f	wherein the video image file with the at least one optical image aberration is corrected by applying digital filtration using the digital signal processor; and
1.g	wherein the corrected video consisting of the digital data optimized from the at least one optical image aberration that are corrected from the original video image is stored in the memory storage sub-system.
2.PRE	The system of claim 1:
2.a	wherein the optical image aberrations include at least one of spherical, comatic, lens distortion, astigmatism, curvature of field, pin cushion, barrel distortion, chromatic aberrations, scattered light, and/or flare types of optical image aberrations.
3.PRE	The system of claim 1:
3.a	wherein the optical image aberration is vignetting;
3.b	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 comers [sic] of the image or the digital signal processor applies both neutral density filtration in the image center and/or an algorithm to lighten the comers [sic] of the image; and
3.c	wherein the image exposure is optimized to correct the vignetting.
4.PRE	The system of claim 1:

Ref	Limitation
4.a	wherein the digital signal processor applies at least one fast Fourier transform (FFT) algorithm to correct the at least one optical image aberration.
5.PRE	The system of claim 1:
5.a	wherein each lens type is registered in the camera database;
5.b	wherein the multiple optical aberrations of each lens is listed in the database;
5.c	wherein the filtration solutions to the lens optical aberrations are listed in the database;
5.d	wherein the filtration of each lens optical aberration is applied by the digital signal processor; and
5.e	wherein after the digital signal processor applies the filtration to correct the optical image aberrations the corrected digital file is forwarded to storage in memory.
6.PRE	A digital imaging system for correcting image aberrations comprising:
6.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
6.b	wherein the optical lens mechanism is a zoom lens or a fixed focal length lens;
6.c	wherein the video is forwarded to storage in memory;
6.d	wherein at least one optical aberration in at least two frames of the digital video are identified using the in-camera software and the integrated circuit;
6.e	wherein the at least one optical aberration from the optical lens mechanism of at least two frames of the digital video are corrected by using the digital signal processor to apply at least one digital filtration algorithm; and
6.f	wherein the corrected digital video file is stored in memory.
7.PRE	The system of claim 6:
7.a	wherein the optical image aberrations include spherical, comatic, lens distortion, astigmatism, chromatic aberrations, curvature of field, pin cushion, barrel distortion, scattered light, and/or flare types of optical aberrations.
8.PRE	The system of claim 6:

Ref	Limitation
8.a	wherein the digital signal processor applies at least one fast Fourier transform (FFT) algorithm to correct the at least one optical image aberration.
9.PRE	The system of claim 6:
9.a	wherein the digital signal processor applies a fast Fourier transform (FFT) algorithm to correct digital aberrations of at least two frames in the digital video.
10.PRE	The system of claim 6:
10.a	wherein the digital signal processor applies color filtration to at least two frames of the digital video image.
11.PRE	The system of claim 6:
11.a	wherein the digital video is filtered to correct at least one optical and/or digital aberrations after initial capture and before the digital video is initially sent to storage.
12.PRE	The system of claim 6:
12.a	wherein the integrated circuit may be a microprocessor, an application specific integrated circuit or a system on a chip.
13.PRE	The system of claim 6:
13.a	wherein the optical image aberration is vignetting;
13.b	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 comers [sic] of the at least two image frames or the digital signal processor applies both neutral density filtration in the image center and/or an algorithm to lighten the comers [sic] of the image of at least two image frames; and
13.c	wherein the image exposure for at least two frames in the digital video file is optimized to correct the vignetting.
14.PRE	A digital imaging system for correcting image aberrations comprising:
14.a	a digital video camera including in-camera software, an optical lens mechanism, at least one digital sensor for capturing digital video, an integrated circuit including a digital signal processor configured to access a database management system including a plurality of optical image aberration corrections, and a memory storage sub-system;
14.b	wherein the optical lens mechanism is a zoom lens;
14.c	wherein the zoom lens changes focal length positions;
14.d	wherein when the digital video is forwarded to the digital signal processor and to memory;

Ref	Limitation
14.e	wherein the integrated circuit uses system software to access the database to identify at least one optical aberration in at least one frame of the video at any focal length of a zoom lens configuration;
14.f	wherein the integrated circuit accesses the database to obtain at least one filtration correction algorithm to the optical image aberration of at least one frame in the video file and forwards the at least one filtration algorithms to the digital signal processor;
14.g	wherein the digital video is forwarded to the digital signal processor which applies at least one filtration algorithm to optimize the digital video and corrects the at least one optical image aberration in at least one video frame for the at least one focal length in the zoom lens configuration; and
14.h	wherein the corrected digital video is stored in memory.
15.PRE	The system of claim 14:
15.a	wherein the optical aberrations include vignetting, spherical, comatic, lens distortion, chromatic aberrations, curvature of field, pin cushion, barrel distortion, scattered light, and/or flare types of optical aberrations.
16.PRE	The system of claim 14:
16.a	wherein the digital signal processor applies a fast Fourier transform (FFT) algorithm to correct optical and/or digital aberrations in the digital video.
17.PRE	The system of claim 14:
17.a	wherein each focal length of a zoom lens in at least one video image frame is analyzed for a different set of optical aberrations.
18.PRE	The system of claim 14:
18.a	wherein the digital signal processor applies color filtration to at least one frame of the digital video image.
19.PRE	The system of claim 14:
19.a	wherein the optical image aberration is vignetting;
19.b	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 at least one image frame 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 of at least one image frame; and

Ref	Limitation
19.c	wherein the image exposure for at least one frame in the digital video file is optimized to correct the vignetting.
20	The system of claim 1, wherein the system is configured to correct red-eye.
21	The system of claim 1, wherein the system is configured to correct for dust.
22	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for spherical aberrations.
23	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for chromatic aberrations.
24	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for scattered light aberrations.
25	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for comatic aberrations.
26	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for astigmatism aberrations.
27	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for lens distortion aberrations.
28	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for pin cushion aberrations.
29	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for curvature of field aberrations.
30	The system of claim 1, wherein the system includes machine readable instructions for the system to correct for barrel distortion aberrations.

APPENDIX B: MATERIALS CONSIDERED

Exhibit	Description
1001	U.S. Patent No. 10,873,685
1002	Prosecution History of U.S. Patent No. 10,873,685
1003	RESERVED
1004	Curriculum Vitae of Leonard Laub
1005	U.S. Patent Publication No. 2005/0280877 ("Watanabe")
1006	Certified Translation of Japanese Patent Application No. JP2004-233872 ("JP-872")
1007	Certified Translation of Japanese Patent No. JPA 2004-343358 ("Kishida")
1008	Certified Translation of Japanese Patent Application Publication JP 2004-328506A ("Kita")
1009	U.S. Patent Publication No. 2003/0223007 A1 ("Takane")
1010	Certified Translation of Japanese Patent No. JP 06-319106A ("Hisamatsu")
1011	U.S. Patent Publication No. 2004/0264918 ("Turner")
1012	U.S. Patent No. 8,559,743 ("Liege")
1013	U.S. Patent No. 7,688,384 ("Davis")
1014	U.S. Patent Publication No. 2006/0132646 ("Komatsu")
1015	SMPTE 244M-2003 SMPTE Standard for Television – System M/NTSC Composite Video Signals – Bit-Parallel Digital Interface, The Society of Motion Picture and Television Engineers (2003) ("SMPTE-240")
1016	SMPTE 170-M-2004 SMPTE Standard for Television – Composite Analog Video Signal – NTSC for Studio Applications, The Society of Motion Picture and Television Engineers (2004) ("SMPTE-170M")
1017	National Television System Committee, NTSC Signal Specifications (Dec. 1953)
1018	PCT Publication No. WO 2004/093438 A1 ("Dutta")
1019	Texas Instruments, TMS320C8x System-Level Synopsis (Sep. 1995)
1020	Texas Instruments, Product Bulletin: TMS320C5470 and TMS320C5471 System-Level DSPs (2002)
1021	Chaoui, Jamil, et al. "Open multimedia application platform: enabling multimedia applications in third generation wireless terminals through a combined RISC/DSP architecture." <i>2001 IEEE International Conference on Acoustics, Speech, and Signal Processing. Proceedings</i> (Cat. No. 01CH37221). Vol. 2. IEEE, 2001.

Exhibit	Description
1022	U.S. Patent No. 9,063,982 (“Bestgen”)
1023	U.S. Patent No. 6,920,443 (“Cesare”)
1024	U.S. Patent Publication No. 2006/0268357 A1 (“Vook”)
1025	U.S. Patent No. 5,739,691 (“Hoenninger”)
1026	Prosecution History of U.S. Patent No. 8,451,339
1027	Dkt. No. 88, Claim Construction Memorandum Opinion and Order, <i>Optimum Imaging Technologies LLC v. Canon Inc.</i> , No. 2:19-cv-00246 (E.D. Tex. June 11, 2020)
1028	<i>digital filter</i> , Comprehensive Dictionary of Electrical Engineering (2d ed. CRC Press 2005)
1029	<i>database management system</i> , Newton’s Telecom Dictionary (CMP Books, 2005)
1030	<i>Canon Inc. v. Optimum Imaging Technologies LLC</i> , IPR2020-1322, Paper 1 (Jul. 20, 2020) (“-01322 Petition”)
1031	<i>Canon Inc. v. Optimum Imaging Technologies LLC</i> IPR2020-1322, Paper 9 (Mar. 1, 2021) (“-01322 D.I.”)
1032	<i>Canon Inc. v. Optimum Imaging Technologies LLC</i> , IPR2020-1321, Paper 1 (Jul. 20, 2020) (“-01321 Petition”)
1033	<i>Canon Inc. v. Optimum Imaging Technologies LLC</i> , IPR2020-1321, Paper 10 (Mar. 1, 2021) (“-01321 D.I.”)
1034	U.S. Patent No. 6,529,237 (“Tsay”)
1035	U.S. Patent Publication No. 2006/0050335 A1 (“Dorrell”)
1036	U.S. Patent Publication No. 2006/0098253 A1 (“Masuno”)
1037	Dkt. No. 1, Complaint, <i>Optimum Imaging Technologies LLC v. Sony Corp.</i> , No. 4:23-cv-00928 (E.D. Tex. Oct. 18, 2023)
1038	RESERVED
1039	RESERVED
1040	U.S. Patent No. 7,206,136 (“Labaziewicz”)
1041	U.S. Patent No. 5,444,482 (“Misawa”)
1042	U.S. Patent No. 5,742,806 (“Reiner”)
1043	U.S. Patent No. 7,245,319 (“Enomoto”)
1044	Certified Translation of Japanese Patent No. JPH (1999)-313250 (“Yamagata”)
1045	U.S. Patent No. 5,905,530 (“Yokota”)
1046	U.S. Patent Publication No. 2004/0150732 (“Yamanaka II”)
1047	GUAN et al., <i>Digital Image Correcting Method for Digital Camera</i> (December 2005) (“Ricoh”)

Exhibit	Description
1048	U.S. Patent No. 5,999,330 ("Goosey")
1049	U.S. Patent No. 7,738,015 ("Steinberg I")
1050	U.S. Patent No. 7,590,305 ("Steinberg II")
1051	Certified Translation of Japanese Patent No. JPA 2002-190979 ("Kuniba")
1052	Certified Translation of Japanese Patent No. JPA 2000-184247 ("Imai")
1053	GONZALEZ & WOODS, DIGITAL IMAGE PROCESSING, (Prentice Hall, 2d ed. 2002) ("Gonzalez")
1054	JOHN C. RUSS, THE IMAGE PROCESSING HANDBOOK (CRC Press, 4th ed. 2002) ("Russ").
1055	U.S. Patent No. 7,609,297 ("Master")
1056	U.S. Patent Publication No. 2007/0080280 ("Havens")
1057	U.S. Patent No. 7,936,392 ("Ng")
1058	Certified Translation of PCT Publication No. WO 2002/069214 ("Takae")
1059	U.S. Patent No. 6,279,004 ("Lee")
1060	Certified Translation of Japanese Patent Application Publication No. JP 2001-251546A ("Iida")
1061	U.S. Patent No. 5,818,524 ("Juen")
1062	M. Gottardi and W. Yang. "A CCD/CMOS image sensor array with integrated A/D conversion." <i>1997 IEEE International Symposium on Circuits and Systems (ISCAS)</i> . Vol. 3. IEEE, 1997.
1063	U.S. Patent Publication No. 2002/0135688 ("Niikawa")
1064	U.S. Patent No. 4,903,204 ("Dobbins")
1065	U.S. Patent No. 5,414,782 ("Carasso")
1066	Certified Translation of Japanese Patent No. JPA 2006-72660 ("Yamazaki")
1067	U.S. Patent Publication No. 2003/0095197 ("Wheeler")
1068	U.S. Patent No. 7,554,584 ("Lim")
1069	U.S. Patent No. 5,630,153 ("Intrater")
1070	U.S. Patent No. 5,864,409 ("Kashida-409")
1071	PCT Publication No. WO 1993-020536 A1 ("Reddig")
1072	U.S. Patent No. 5,475,420 ("Buchin")
1073	U.S. Patent No. 4,562,436 ("Colman")
1074	U.S. Patent No. 6,816,625 ("Lewis")
1075	U.S. Patent No. 6,798,449 ("Hsieh")

Exhibit	Description
1076	P. Strumillo and M. Strzelecki, Fourier Transform of Images, available at http://mstrzel.elel.p.lodz.pl/mstrzel/pattern_rec/fft_ang.pdf (visited May 10, 2024).