UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE

PATENT TRIAL AND APPEAL BOARD

CANON, INC. AND CANON U.S.A., INC.,

Petitioner

v.

WSOU Investments, LLC d/b/a Brazos Licensing and Development,

Patent Owner

U.S. Patent No. 7,493,030
Original Issue Date: Feb. 17, 2009
Title: ADAPTIVE OPTICAL PLANE FORMATION WITH ROLLING SHUTTER

Case No. TBD

DECLARATION OF DR. MICHAEL LEBBY

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I. INTRODUCTION

I, Dr. Michael Lebby, declare as follows:

1. I have been retained by counsel for Canon, Inc. ("Canon") in the above-captioned *inter partes* review as an independent consultant to offer opinions regarding the validity of the challenged claims in U.S. Patent No. 7,493,030 (the "'030 Patent").

2. If requested, I am prepared to explain in a deposition or at a trial before the Patent Trial and Appeal Board (the "Board") the technology disclosed in the '030 Patent, including the state of the art around June 24, 2005, the earliest priority of the '030 Patent. Similarly, I am prepared to explain the technology disclosed in the prior art references cited herein. This may include, among other things, background information on the fields of optical engineering, camera development, and photography.

II. QUALIFICATIONS

3. As described in this Section, and further detailed in my *curriculum vitae* (Exhibit 1011) over the course of my 40-year career in optics and optoelectronics, I have worked in nearly every aspect of the optical and optoelectronics business, ranging from epitaxial wafer growth, optical and optoelectronic device design, using modeling and simulation, optical and optoelectronic device fabrication, testing, and qualification, to the implementation

of devices into packages, both hermetic and non-hermetic, as well as analysis of package materials such as plastics (including plastic housings such as resin-packaged lead frame housings), metallic-based packages, semiconductor-based packages, and ceramic-based packages. I have also designed device packages (through-pin, surface mount, flip-chip, and various combinations thereof) for printed circuit board mounting. Many of the designed packages were implemented into modules and sub-system/luminaire applications. The modules have been fiber-optic-, display-, lighting-, imaging-,and sensing-based. I have also worked in commercially based industrial research-and-development laboratories to bring new optical-, optoelectronic- and photonic-based technologies from the research proof-of-concept phase through prototyping and qualified manufacturing for volume release. I have been both an entrepreneur (*e.g.*, Ignis Optics Inc, One Chip Photonics, Lightwave Logic Inc.), as well as an intrapreneur (*e.g.*, Motorola, Intel, TE Connectivity (previously Tyco Electronics), AT&T Bell Labs), creating innovative new programs, both as venture backed start-ups as well as corporate funded divisions. I have built these entities to develop optical, optoelectronics and photonics technology from the laboratory and fabrication clean room to production factories.

4. I received a Bachelor of Electrical Engineering degree in 1984, a Master of Business Administration in 1985, and a Doctorate degree in 1987, all

from University of Bradford in the United Kingdom. My Ph.D. thesis involved the design and fabrication of both optoelectronic and electronic semiconductor devices, and their associated characterization. In 2004, I was awarded a Doctor of Engineering degree (a higher doctorate degree) from University of Bradford for my technical contributions to the field, with citation to "Technical Contributions to Optoelectronics."

5. My career started in the late 1970s at the Ministry of Defense in UK where I spent time at their R&D facility in Malvern (RSRE – Royal Signals and Radar Establishment). I worked on semiconductor device design, fabrication, and characterization, and especially materials using III-V compound semiconductors. I also worked on ceramic-based RF electronic packaging that included low-temperature co-fired ceramic (LTCC). I also worked on electronic circuit design with both analog and digital techniques. My research work in semiconductor device design then took me to AT&T Bell Laboratories in 1985, where I pursued research in novel device designs using III-V semiconductor material systems that included FETs, bipolar transistors, LEDs, laser diodes, and photodetectors. The devices researched became the subject of my PhD thesis that was granted in 1987.

6. I moved to Motorola in 1989 to further develop my optical, optoelectronic, semiconductor engineering and development skills, and I became a Research and Development Manager in the photonics division of Motorola, until I

left the company in 1998. During my time at Motorola, I worked on many photonic technology projects that included optics, display, imaging, camera, fiber-optic optical interconnects, electronic circuits (both analog and digital), displays, LEDs, and laser devices, as well as the packaging and reliability of mobile product prototypes. At that time, I was particularly interested in miniature displays using a number of technologies such as LEDs, lasers, LCDs, and organic LEDs which were aimed towards (at the time) pagers, mobile phones, micro-imagers/displays, and advanced prototypes of futuristic communications hardware. I was also particularly interested in miniature color displays, in which LEDs could be utilized, and the associated drive electronics for them.

7. Unfortunately, in the early 1990s, only red wavelength Phosphide (GaAsP and/or InGaAlP) and AlGaAs based LED technology was advanced in technology and performance. Green wavelength Gallium Phosphide based LEDs had low emission output, and blue wavelength emission LEDs were only available using pure Silicon Carbide on Silicon Carbide substrate wafers, with very low emission output. I worked closely with Motorola's mobile divisions on new and novel display prototypes to research and develop how best to innovate with full color red, green, and blue displays. A number of alternative technologies were evaluated, such as LCD (Liquid Crystal Displays), OLED (organic LEDs), and Gallium Nitride and Indium Gallium Nitride materials grown onto Sapphire. I also

explored the electronic circuits that were needed to drive, operate, and signal these types of optoelectronic displays.

8. During my time at Motorola as a Research and Development Manager, I designed packages for these displays and devices, which included standard TO-cans, over-molded plastic DIL solutions, and ceramic-based and semiconductor-based technology.

9. The compound semiconductors used in the early 1990s at Motorola corporate research, for which I was a Research and Development Manager, included GaAs, InP, GaN, GaP, and InGaAlP, amongst other materials, all of which were intended to be designed into various light emitting sources and detectors in their associated package platforms. The research work at Motorola also included work on displays and, in particular, miniature displays for pagers, clam-shell phones, and head-mounted displays that included mounting onto eyeglasses (similar in concept to Google glass™). The types of displays ranged from large arrays of visible LEDs (*i.e.*, 10,000 LEDs on a chip) that required custom LED packaging to tiny color LCDs, where work was conducted into approaches to efficiently package the displays. As the arrays were large, on-board integrated LED driver circuits were implemented in some of the prototypes. Some of the research work at Motorola utilized phosphor technology, especially for display projects that were based on field emission (*i.e.*, the field emission display

(FED)), as well as arrays of visible LED displays where a full color gamut was required by both internal and external customers. The phosphor technology performed down-conversion of light energy.

10. I also initiated Motorola's work in optical interconnect (Optobus™) technology, and was involved in research and development of the IC chip designs that this parallel interconnect module utilized.

11. I was one of Motorola's most prolific inventors, having over 150 issued utility patents as an inventor or a co-inventor. Many of the photonics prototypes with which I was involved were subject to reliability and stress testing that included humidity, temperature, optical, mechanical, and electrical evaluation. These consumer products all were driven using standard electronic ICs and electronic signaling.

12. I filed my first patent, which taught techniques using GaN and InGaN LEDs, in 1996, shortly after the invention of high performance GaN/InGaN blue LEDs by Nichia in the early 1990s. My work at Motorola addressed, in part, the big issue at the time in the mid-1990s: full color display and display electronics composed of red, green and blue LEDs that could be utilized in mobile products as well as other applications. As part of this work, I was engaged in how to package these technologies that allowed for electrical, optical, and thermal high performance. Examples of patents on which I am a co-inventor, with respect to

high heat conductivity surface emitting optical devices, include, for example, U.S. Patent No. 5,538,919, as well as U.S. Patent No. 5,818,404, U.S. Patent No. 5,739,800, and U.S. Patent No. 5,838,703, which three patents address LED packaging solutions.

13. Another of my inventions was directed to a new semiconductor laser that had the potential to be manufactured in high volume. This device was called a VCSEL (vertical cavity surface emitting laser), and the invention was to optimize the performance using an oxide process, and is now the basis for the highest volume semiconductor laser today (with its recent implementation into Apple's new iPhone Face ID system, in addition to being the laser diode utilized for the past decade in laser mice for personal computers). The VCSEL is a surface emitting diode laser and operates in a similar fashion to most LED chips today. Some of the goals of the research work at Motorola was to be able to package these VCSEL laser diodes in a similar approach to LEDs. Laser diodes require thermal issues to be addressed very carefully, as they develop significant levels of heat during operation. The package designs at the time (including for lasers and LED packages) took into account thermal heat sinking and thermal paths to take the heat away from the source. My additional patents, including during my time at Motorola, are listed in my *curriculum vitae* (Appendix A).

14. Between 1998 and 1999, I worked as the Director of Technology/ BD (Fiber Optics) for Tyco Electronics (previously AMP). I joined Tyco Electronics as a member of the Global Optoelectronics Division's management team. I was responsible for growing the optoelectronics business through external interactions that included mergers, acquisitions, strategic alliances, and technical strategic planning. Much of that work was laser- and LED-based, and included designing and characterizing laser- and LED-based packages and modules for customer qualification specifications.

15. In 1999, I left Tyco and started employment at Intel. At Intel, I was involved heavily in photonic technology, especially technology that supported silicon photonic device platforms. As a culmination of this work, I was one of Intel's founders of its silicon photonics division in the year 2000, and worked to set up a fabrication facility in South San Jose. The work involved integrating silicon FET electronics with optoelectronics onto the same silicon semiconductor wafer. I was also part of Intel Capital's optical investment team, and participated in over 30 photonics investments into photonics and especially devices, packaging and modules. Technologies investigated included lasers, LEDs, and displays.

16. At the end of 2000, I left Intel and raised venture capital funding for a company called Ignis Optics Inc. The main goal of the company was to design and manufacture, in high volume, very high-performance fiber optic transceiver

modules with data rates up to OC-192, or approximately 10 Gbps. The fiber optic transceiver modules have the capability of transmitting and receiving optical signals that are controlled using programmable electronics and packaged optoelectronics chips, such as laser diodes and photodetectors. The optoelectronics chips were packaged using laminated ceramic-based technology as can be seen in my patents, for example, U.S. Patent No. 6,999,644 (a discrete optoelectronic package for a laser diode, with a provisional filing of 15th February 2002). In this patent, a laser diode chip is mounted onto a laminated ceramic package with electrical and thermal design features. Further, other of my patented inventions, such as U.S. Patent Nos. 6,663,296 and 6,795,461, also teach the use of a laminated ceramic package for a surface emitting laser diode and/or light emitting diodes, with a priority date of 23rd April 2001. I am also an inventor or co-inventor on ceramic-based optoelectronic packaged patents that were designed for thermal engineering issues, dating to the 1990s, for example: U.S. Patent Nos. 5,045,908; 5,125,054; 5,959,315; 5,228,101; 5,313,545; 5,337,391; 5,361,317; 5,369,529; 5,416,870; 5,428,704; 5,521,992; 5,545,359; 5,539,200; 6,064,780; 5,543,958; 5,486,946; 5,625,734; 5,739,800; and 5,905,750; as well as EP0633607A1; EP0635741A2; and JPH0756062A.

17. In 2005, I took up employment for a trade association, based in Washington, D.C., called IEEE Optoelectronics Industry Development Association

(OIDA). As head of this trade association, and with photonics manufacturers that included fiber optics, display, cameras, sensing, defense, aerospace, LED lighting, and automotive vendors as members, I was responsible, in part, for industry-based technology roadmaps; and I implemented common industry roadmap methodologies with common features such as "Red Brick Walls" and transferred them into optoelectronics roadmaps for the industry in which LEDs, fiber-optics, optics, fiber, cameras, optical sensors, displays, and their associated packaging, were featured.

18. In 2010, I became the General Manager and CTO of Translucent, Inc., a high-tech start-up company which developed and manufactured silicon and rare earth oxide based epitaxial semiconductor wafers. One of the key drivers at Translucent was to develop a new and novel platform for the growth of GaN and InGaN onto silicon for low cost LED manufacturing on larger format substrate wafers (*e.g.*, 200mm), in order to achieve economies of scale and lower chip costs. Translucent pioneered the deposition of single crystal rare earth oxides such as Erbium Oxide (ErOx), Gadolinium Oxide (GdOx), Neodymium Oxide (NdOx), etc., that, when grown, single crystal layers of GaN/InGaN/AlN could be grown on top of them. This allows a lattice-matched, and monolithic-based, wafer template to be manufactured for LED fabrication. While at Translucent, I researched various epitaxial semiconductor layer structures that utilized rare earth oxide

technology in order to improve the performance of LEDs used individually, as well as in array form. Other material growth work at Translucent focused on the growth of Silicon Germanium (SiGe) compounds with rare earth oxides, and various crystal orientation wafer substrates.

19. I am currently Chief Executive Officer (CEO) and Chief Technology Officer (CTO) of Oculi, LLC. Oculi, LLC is my consulting company, through which I engage in my expert witness work.

20. I also presently hold the position of CEO of Lightwave Logic Inc. (LWLG), where I also serve as a Director of the Board of Directors. Lightwave Logic is a company that is developing optical polymer modulators for the fiber optic communications industry.

21. Throughout my career, I have also had an active role in a number of technical professional organizations, including, among others, IEEE Components, Packaging, and Manufacturing Technology (CPMT), IEEE Electronic Components and Technology Conferences (ECTC); IEEE TC-10 (Technical Committee on Optoelectronics), and IEEE Optoelectronics Industry Development Association (OIDA). Through these organizations, I have consistently been a part of committees, events, and workshops relating to semiconductor, optoelectronics, electronics, and packaging technology.

22. I also serve as a Technical Expert/Consultant for the European Commission. In my work at the European Commission, I review and advise on general electronics, photonics, optics, imaging, sensing, display, and related ICT (Information and communications technology) technology.

23. My work has also led to over 200 USPTO utility patents in semiconductors, electronics, and optoelectronics, including a number of patents relating to LED technology. I am the author of more than 60 publications.

24. A current copy of my *curriculum vitae*, Exhibit 1011, provides further information concerning my experience and qualifications and includes: a list of my patents, a list of the publications I have authored, and a list of the matters on which I have served as an expert witness.

III. COMPENSATION

25. I am being compensated for my work in this matter at my standard hourly rate for consulting services.

26. My compensation is not contingent upon the opinions I render or the outcome of this proceeding.

IV. MATERIALS CONSIDERED

27. In preparing this declaration, I reviewed and considered the following materials, and any others referenced in the body of my declaration:

- The ’030 Patent (Ex. 1001) and its file history (Ex. 1012).

- Japanese Patent Application Publication No. 2002-318342, ("**Sugitani**"), including a certified English translation (Ex. 1003).
- Japanese Patent Application Publication No. 2001-103366 ("**Kubo**"), including a certified English translation (Ex. 1004).
- Japanese Patent Application Publication No. 2003-121913 ("**Misawa**"), including a certified English translation (Ex. 1005).
- U.S. Patent No. 6,369,954 ("**Berge**") (Ex. 1006).
- Japanese Patent Application Publication No. 2003-319239 ("**Shibata**"), including a certified English translation (Ex. 1007).
- U.S. Patent Application Publication No. 2003/0174234 ("**Kondo**") (Ex. 1008).
- U.S. Patent Application Publication No. 2003/0086008 ("**Nagano**") (Ex. 1009).
- U.S. Patent No. 4,410,804 ("**Stauffer**") (Ex. 1010).
- U.S. Patent Application Publication No. 2003/0007076 ("**Okisu**") (Ex. 1013).
- U.S. Patent Application Publication No. 2003/0081137 ("**Yamazaki**") (Ex. 1014).
- U.S. Patent No. 5,282,045 (Ex. 1016).

28. I may use these documents and information, or other information obtained during the course of this proceeding, as well as representative charts, graphs, schematics and diagrams, animations, and models based on those documents and information, to support and to explain my testimony.

29. My opinions are based in part on a review and analysis of the above-mentioned documents and materials. I have also drawn on my education,

experience, and knowledge of basic engineering principles in forming my opinions.

V. UNDERSTANDING OF THE LAW

A. Legal Standards

30. I am not an attorney, but I have been informed of several legal principles concerning patent validity, which I have employed in forming my opinions in this declaration. I have been informed and understand that each patent claim is considered separately for purposes of validity and that a dependent claim that depends from another claim includes all of the limitations of the claim it depends from.

31. ***Claim Construction***. I have been informed and understand that the claims of the challenged patents in this proceeding are to be construed using the same claim construction standard applied in district court. I have been informed and understand the claim construction analysis begins with the ordinary meaning of a claim term, and there is a presumption that the term carries its plain and ordinary meaning to persons of ordinary skill in the art as of the effective filing date of the patent. I have also been informed and understand that the most important sources for determining the meaning of a claim term are the claims, the specification, and the prosecution history of the patent at issue, which collectively is called "intrinsic evidence." I have been further informed and understand that the

meaning of a claim term may also be guided by "extrinsic evidence," such as contemporaneous dictionaries and treatises.

32. ***Burden of Proof***. I have been informed and understand that the petitioner in an *inter partes* review bears the burden of establishing invalidity by "a preponderance of the evidence." I have been further informed and understand that, to prove an assertion by "a preponderance of the evidence," the party with the burden of proof must demonstrate that it is more likely than not that the assertion is true.

33. ***Obviousness***. I have been informed and understand that a patent claim is invalid if it would have been obvious to a person of ordinary skill in the art at the time of the claimed invention. I have been further informed and understand that a claimed invention is not patentable if differences between it and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the pertinent art. I have been informed and understand that factors relevant to the determination of obviousness include the scope and content of the prior art, the level of ordinary skill in the art at the time of the invention, differences between the claimed invention and the prior art, and "secondary considerations" or objective indicia of non-obviousness.

34. I have been informed and understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I have been further informed and understand that when a patent claim simply arranges old elements with each performing the same function it had been known to perform, and yields no more than one of ordinary skill would expect from such an arrangement, the combination is obvious.

35. I have been informed and understand that a patent claim composed of several limitations is not obvious merely because each limitation was independently known in the prior art. Hindsight reasoning is not an appropriate basis for combining references to form an obviousness combination. I have been further informed and understand that it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine multiple prior art references.

36. I have also been informed that the near-simultaneous invention by others can be evidence that a claimed invention is obvious. I have further been informed and understand that the patentee bears the burden of showing a "nexus" between the claimed invention and the evidence proffered on secondary considerations (e.g., proof of commercial success of a product that practices the claimed invention is not enough; there must be evidence that the commercial success resulted, at least in part, from the claimed invention).

B. Priority Date

37. I have been informed and understand that a U.S. patent may claim "priority" to the filing date of one or more earlier filed applications. I have been informed that the priority date, also called the "effective filing date," is the earliest filing date to which a claim is entitled and that such date is relevant for determining what qualifies as prior art. I understand that a claim must have written description support in the application(s) to which it claims priority to be entitled to an earlier effective filing date. I have been informed that the priority date determination is done on a claim-by-claim basis and that claims in the same patent may have different priority dates. I have been instructed to use June 24, 2005 as the priority date for all of the challenged claims in the '030 patent.

C. Level of Skill in the Art

38. I have been informed and understand that the level of ordinary skill in the relevant art at the time of the invention is relevant to inquiries such as the meaning of claim terms, the meaning of disclosures found in the prior art, and the reasons one of ordinary skill in the art may have for combining references.

39. I have been informed and understand that factors that may be considered in determining the level of ordinary skill include: (1) the type of problems encountered in the art; (2) prior art solutions to those problems; (3) rapidity with which innovations are made; (4) sophistication of the technology; and

(5) education level of active workers in the relevant field. I have been further informed and understand that a person of ordinary skill in the art is also a person of ordinary creativity.

40. The challenged patents pertain generally to the field of cameras and optics. Given that by the priority date of the ’030 patent cameras were largely digital devices that ran programs to accomplish their desired functions, a person of ordinary skill in the art (“POSITA”) at the time of the alleged invention would have had a bachelor’s degree in electrical engineering, physics, or computer science, or an equivalent degree, and two to three years of experience in the field of optical engineering. I was at all relevant times at least a POSITA in the art relevant to the challenged patents.

VI. TECHNOLOGY BACKGROUND AND STATE OF THE ART

41. The ’030 patent is entitled “Adaptive Optical Plane Formation with Rolling Shutter” and relates to optical devices that aim to provide an increased depth of field within an image by altering the focus distance of a lens during a single exposure. While this technique was well-known in the art as disclosed in the art discussed herein, it is different from the far more typical process of setting one specific focus distance on the subject and then exposing the entire frame at that focus distance. One way to easily grasp the nature of ’030 patent’s disclosure is with reference to Fig. 10B, in which the image is broken up into a series of sub-

exposures and the camera changes the focus distance for each sub-exposure so that the subject within that sub-exposure is in focus.

42. As I explained in more detail below, by the June 2005 priority date of the ’030 patent, the field of camera development was well established and built upon the decades old understanding of basic photography principles. While the 1990s showed the advancement of digitized cameras to the mass consumer, the basic principles of photography with respect to key functions such as focus, depth of field, and how images were collected by a camera, essentially remained the same.

43. Thus, it was a crowded art where the concepts employed in the field were well understood, predictable, and routinely mixed and matched as needed to achieve a POSITA’s design goals. This was especially the case for placement of objects, making sure what was in focus and out of focus, lighting that object, and being able to accurately convey the object into an image.

A. Basic Photography Principles

44. The ’030 patent assumes a POSITA understands some basic photographic principles. First, taking a photograph involves two somewhat interrelated acts: (1) placing the object to be photographed in focus; and (2)

exposing the light sensitive surface of the camera (*e.g.*, film or electronic image sensor)[1] for the appropriate amount of time to capture an acceptable image.

45. Placing the object in focus typically involves manipulating the physical relationship between the sensor and the lens, such as the distance between the lens and the sensor. And the specific physical relationship between the lens and the sensor that brings the object in focus will be dictated by the object's distance from the camera.

46. Selecting the appropriate exposure time depends firstly on the brightness of the object. With everything else being equal, dimmer objects need to be exposed for a longer period of time than brighter objects.

47. The exposure time period in a camera is typically controlled by the camera's shutter and is called shutter speed. The specific shutter speed needed to expose a particular object depends on two other variables: lens aperture and sensor sensitivity.

48. Specifically,

- Lens aperture describes the size of the opening that light can pass through in the lens. Most lenses have a variable aperture so the size

[1] For simplicity, the light sensitive surface will simply be referred to a sensor going forward.

of this opening can be increased or decreased. All else being equal, a larger aperture (e.g., bigger opening)[2] allows more light to hit the sensor and requires a short exposure time period, while a smaller aperture does the opposite.

- Sensor sensitivity describes the amount of light needed by the sensor to properly capture an image. All else being equal, a highly sensitive sensor will be able to properly expose a dim object but will create a washed-out (or low contrast) image for a bright object, while a less sensitive would do the opposite.

49. When selecting shutter speed, object movement must be considered. If an object moves while the sensor is being exposed to create an image, the object can be blurry in the image.

50. Aperture has an impact on depth of field, which relates to focus. Depth of field refers to the range of distances from the lens that will be in acceptable focus.

[2] In photography, an aperture is typically specified by its "*f*-number," which is a ratio of focal length to effective aperture, in dimensionless units denominated *f* /x.x (e.g., *f* / 1.4). This can cause some confusion to the uninitiated because a larger *f*-number represents a smaller aperture. For example, an *f* / 22 aperture is much smaller than an *f* / 1.8 aperture.

51. Specifically, small apertures have wider depth of field, while wider apertures typically have narrower depth of field. For a very small aperture–such as a pinhole—the depth of field is typically very large and objects will tend to be in focus regardless of their distance from the camera. In contrast, wide apertures typically result in a very shallow depth of field, such that if one object is in focus another object a few inches or feet in front or behind the object can be out of focus. Depth of field is also impacted by focus distance such that focusing on objects close to the camera will result in a shallower depth of field than focusing on objects far from the camera.

52. Sensor sensitivity will have an impact on noise in the image, such that highly sensitive sensor settings tend to produce noisier images than lower sensitivity setting.

53. The three variables of shutter speed, aperture, and sensor sensitivity can be varied in an interrelated way to obtain proper exposure at a given object brightness. For example, a higher sensor sensitivity can compensate for a smaller aperture or shorter exposure period.

54. However, there are trade-offs in depth of field, blur, and noise that result from adjusting one variable versus another. Photographers and camera engineers have long understood these various trade-offs and employ them based on

the specific imaging conditions of the object being photographed to create the desired image results available under the conditions available.

VII. THE '030 PATENT

A. Problem Addressed by the '030 Patent

55. In view of the basic photography principles I described above, the '030 patent describes depth of field using Fig. 2B (labeled prior art, reproduced below), which is a photograph of obliquely arranged dominos (with the domino on the left closest to the camera and the dominos get progressively further away from left to right across the image). '030 Pat. 1:59-2:6. The middle domino 26 labeled S0 is in sharp focus, while the dominos in front and behind it are progressively more and more out of focus. *Id.* While this is a somewhat subjective determination, the patent considers dominos 25 and 27 to be in acceptable focus.

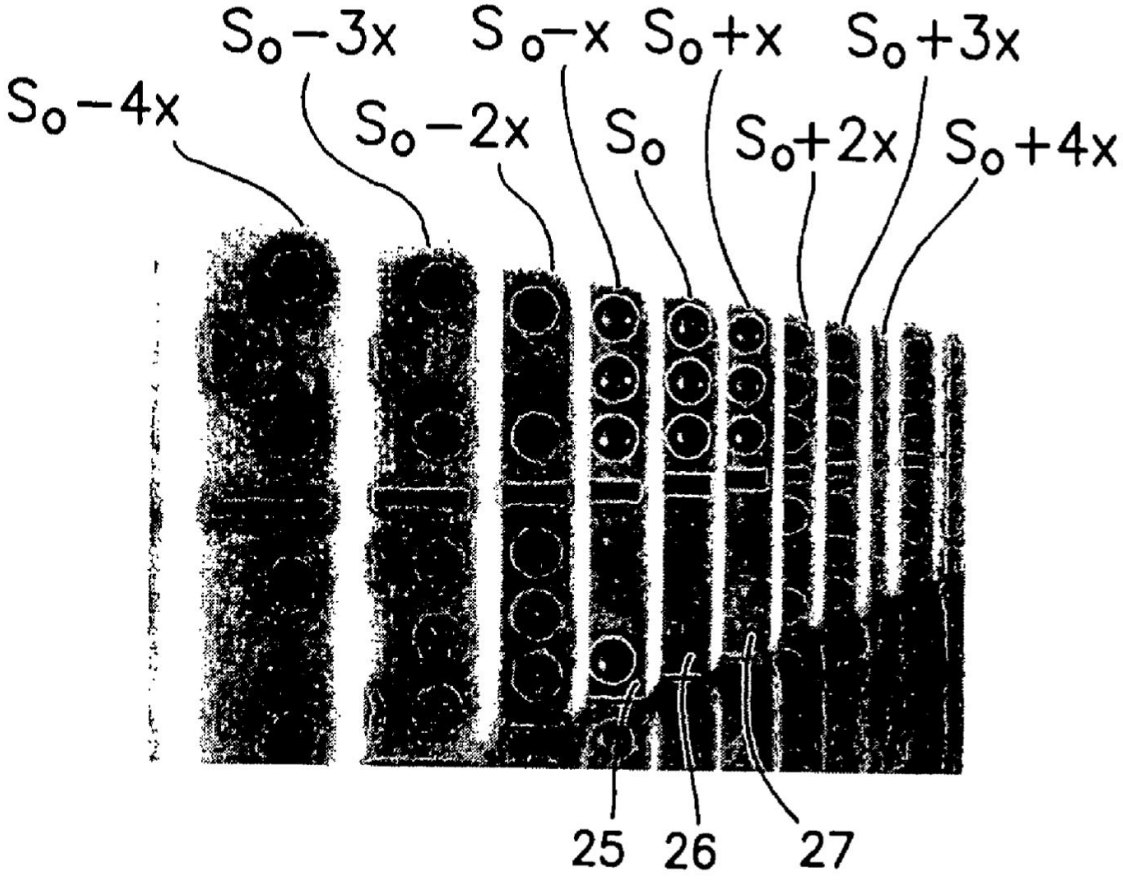
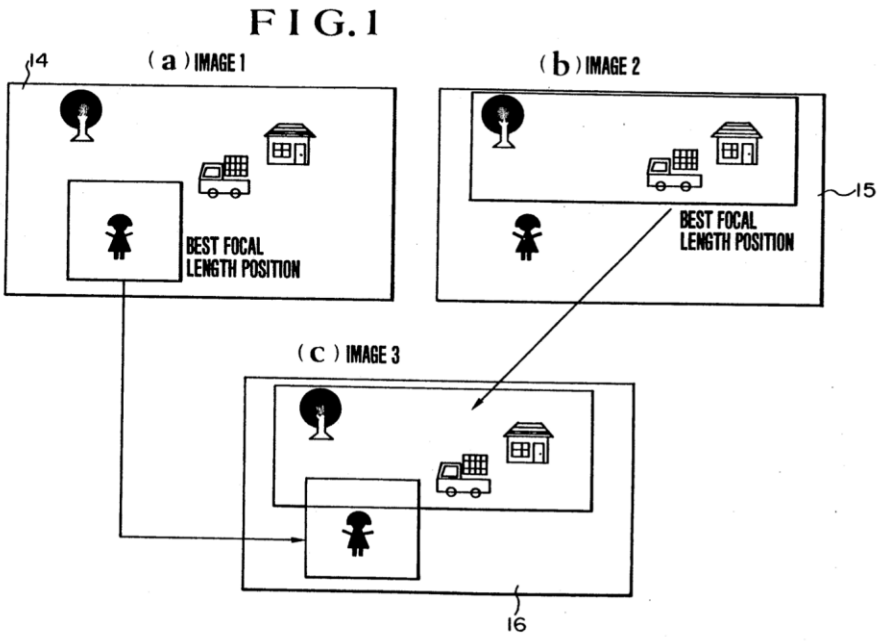


FIG.2B
PRIOR ART

56. Beyond merely using a smaller aperture setting (*i.e.*, a larger *f*-number), the '030 patent describes a variety of prior art solutions for increasing the depth of field when photographing obliquely arranged objects, like the dominos in Fig. 2B. One prior art way of addressing the issue is to use a tilt-shift lens like the Canon TS-E 24mm, which tilts the lens relative to the focal plane. '030 Patent at

2:17-39. Prior art U.S. Patent No. 6,783,068 discloses a similar approach which tilts the randomly addressable image sensor relative to the lens. *Id.* at 2:40-49. Prior art U.S. Patent No. 6,567,126 similarly discloses a tilting image sensor and describes adaptively controlling the exposure of the sensor with the focus detection device. *Id*. at 2:50-63. Prior art U.S. Patent No. 6,445,415 discusses a multi-photo technique in which several photos are shot with different focused parts of the scene subjects in the respective photo, and a basic image is integrated by contributions from the different images. *Id.* at 2:64-3:5.

57. The ’030 patent further discusses prior art patent U.S. Pat. No. 5,282,045, is titled “Depth of Field Control Apparatus and Image Pickup Apparatus Having the Same Therein.” *Id*. at 3:6-8. As shown in Fig. 1 (below), the’045 patent recognizes that, in some scenes, the best focal length for different objects in the scene might be different, such that a composite image like (c) is necessary for there to be a good focus condition across the entire scene. *See* U.S. Patent No. 5,282,045 (Ex. 1016) at 4:15-27, Fig. 1:



58. The ’045 patent further explains that “the increase in aperture makes depth of field shallow … in the case of shooting a person, if the best focal length is set to the person, a background scenery thereof is completely out of focus.” *Id*. at 2:5-11.

59. The ’045 patent also describes that “there has been a well-known technique in which images located in a plurality of different focal lengths are composed to obtain a wide depth of field.” *Id*. at 1:53-56. The ’045 patent describes further solutions for obtaining wide depth of field when objects are moving, determining the timing of shifting the focal point, and performing image read out at the speed needed to capture television images.

60. The ’030 patent acknowledges these known teachings of the ’045 patent, including providing: “a mechanism for changing a focal point or length

position," "[m]otion information…obtained by a circuit detecting a moving portion of an object to control the image composition" based on the motion information, and controlling the movement of the focus system in conjunction with the aperture of the camera lens. '030 Patent at 3:6-32.

61. However, the '030 patent criticizes the '045 patent, as well as the other prior art described, that they "appear to overlay different planar images of objects within a scene to arrive at a composite having a higher depth of field." *Id.* at 3:33-36.

B. Description of the Alleged Invention of the '030 Patent

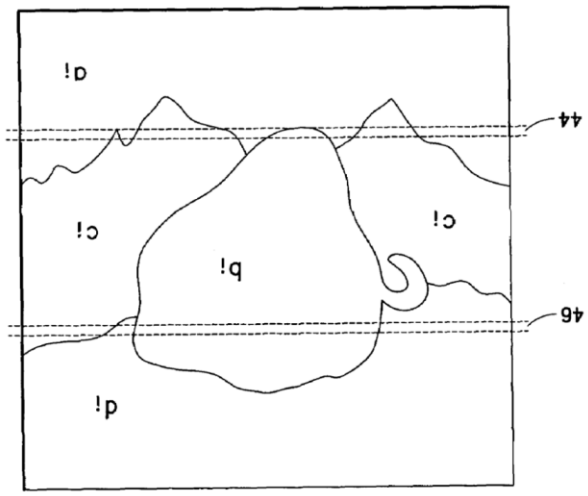
62. In view of the above described prior art, the '030 patent describes its purportedly inventive method as "manipulating an optical relationship between an optical lens and an image sensing surface, and ***exposing different portions*** of the image sensing surface ***synchronous with manipulating the optical relationship***." *Id.* at 4:17-32.

63. Put it differently, unlike the prior art described in the '030 patent—which is characterized as superimposing images taken at different object distances—the '030 patent teaches exposing different sub-regions of the sensor with the distance changing for each sub-region. In this way, different distances are set for different objects and captured within a single exposure of the image sensor, as opposed to the prior art, which took multiple pictures of a scene with different

areas in focus and composited them together, such that the final combined image contained the in-focus areas from the source pictures.

64. This concept is illustrated in the ’030 patent with reference to Fig. 10A and 10B, below, which shows a mastodon and other objects at different distances.[3]

FIG. 10A



65. The mastodon is at one object distance (b_i), while the foreground (d_i), hills (c_i), and sky (a_i) are at different object distances. *See id.* at 10:38-55 (describing each of these items including background such as the sky as objects).

[3] I have rotated Fig. 10B to match the orientation of Fig. 10A. *See*, ’030 Pat. at 10:40-42.

66. The patent does not describe the technology required to carry out its disclosed technique in any significant detail. For example, rather than providing the technical detail regarding how to partition the scene into different objects and measure their distance, the '030 patent explains that known distance measuring equipment (such as an auto focus apparatus) is used to determine the distance of these objects. *Id.* at 10:61-64. "Pixels along the sensor surface 40b that correspond to the various objects are then exposed only when the lens 38 is at the proper imaged distance for that particular object." *Id.* at 10:62-67.

67. The '030 patent does describe using prior art curtain shutters to create a slit of variable width by using two curtains that travel in front of a photographic film. *Id.* at 6:16-19. The patent further provides a functional description of how shutter speed is changed using prior art curtain shutters by changing the time that elapses between the release of the first and the second shutter curtains, exposure time changes and the width of the slit determines the total time any part of the film is exposed. *Id.* at 6:19-26.

68. The '030 patent further describes that: "Field curvature is corrected in the resulting image to the precision of the distance measuring equipment, depth of field is greatly increased because the resulting image is made from four image distances rather than one." *Id.* at 11:20-24.

69. The ’030 patent further discloses that exposure for each independently exposed region of the sensor in Fig. 10B, *i.e.*, a_i, b_i, c_i, and d_i, can be independently set. *Id.* 11:26-58. That is, because the camera is effectively taking four independent pictures, each picture created by a sub-region of the image sensor, each can be treated like a traditional independent picture with the exposure settings being set for the subject matter.

70. Additionally, the ’030 patent functionally describes the idea that object motion can be accounted for when photographing each sub-image and that the function can be embodied by existing hardware. Specifically, the ’030 patent states: “[u]sing known movement detection equipment that operates on the same principle of distance measuring equipment, movement of different objects within a scene may be categorized, and pixels corresponding to the individual objects may be exposed for short or longer period[s] depending on the relative movement of the objects themselves. Determining the exact pixels for which a fast-moving object is to be captured is merely a matter of extrapolating which pixels would image the moving object at the time the lens is at that object’s image distance based on (past) detected movement.” *Id. at* 11:64-12:7 (emphasis added).

71. The brevity of the ’030 patent’s descriptions, which provides no detail as to how any of the above would actually be accomplished in practice, shows the ’030 patent’s recognition that the technology for implementing the invention was

well known to a POSITA in this field. This brief description is unsurprising, since at least by early 1980s, cameras like the Nikon FA's 5-segment included exposure metering systems that provided the basis of the of matrix metering. And by 1996, cameras like the Nikon F5 supported multiple exposures. *See* https://www.mir.com.my/rb/photography/hardwares/classics/NikonF5/exposure/index.htm. At least by late 1990's, it was well-known in photography to synthesize images captured at different exposure times. Moreover, by 2005 filing date of the '030 patent, digital camera development was also well-established. For example, by that time Canon had been making digital SLRs for ten years. *See* https://global.canon/en/c-museum/year_search.html?t=camera&s=dslr&y2=2005. And it had released over 70 digital camera models. *See* https://global.canon/en/c-museum/year_search.html?t=camera&s=dcc&y2=2005. Other well-known manufacturers would have had similar offerings.

72. The '030 patent also does not describe how to embody distance measuring equipment (or auto focus mechanism), light sensing equipment, and/or motion sensing equipment, correctly assuming all those devices would be well known to a POSITA. Indeed, all of these features were routinely implemented in cameras such as SLR cameras by at least the late 1990's. For example, the Nikon F5, released in 1996, supported five-area autofocus sensors, dynamic autofocus for moving subjects, and 1005-pixel RGB sensor to read a scene's color, brightness

and contrast. Whereas by 2004, Canon's EOS-1Ds had a 16-megapixel sensor, a 45 point autofocus with automatic selection of focus point, as well as a variety of other advanced features. *See* https://global.canon/en/c-museum/product/dslr787.html.

C. Prosecution History of the '030 Patent

73. The '030 patent stems from Application No. 11/165,992. Prosecution began with a restriction and election followed by a non-final Office Action. Ex. 1012 at pp. 104-122 (July 1, 2008, Office Action). The prior art rejections in that Office Action were: anticipation by U.S. Patent No. 3,537,373 to Land; and obviousness by Land in view of U.S. Patent No. 4,484,233 to Strout *et al*. *Id*.

74. Certain claims were also provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over Applicant's co-pending application (U.S. Application Publication 2007/0031136). *Id*. The Examiner also found selected dependent claims allowable.

75. The Applicant amended the claims to recite the subject matter that the Office Action deemed allowable and submitted a terminal disclaimer to address the double patenting rejection. *Id*. at pp. 134-143.

76. A Notice of Allowance was issued. *Id*. at pp. 146-151 (December 11, 2008, Notice of Allowance). Other than Land and Strout, the Examiner made no use of any other prior art of record.

VIII. CLAIM CONSTRUCTION

77. In my opinion, apart from the two claim limitations discussed below, the claims of the ’030 patent can be interpreted according to their ordinary meanings without construction for the purpose of this IPR.

A. “Within a Continuous Exposure Frame” (Claim 11)

78. In my opinion, the term “within a continuous exposure frame” that is found in Claim 11 should be construed as “within the period from the start of an exposure of the imaging sensing surface until the entire image sensing surface is exposed once.”

79. In light of the ’030 patent’s disclosure, a POSITA would have considered this to be the correct construction. In fact that the ’030 patent defines the term “continuous exposure frame” to have this very definition at 9:20-25: “FIG. 8 illustrates the condition where the lens 38 moves continuously in one direction during a single frame period, such as when imaging the inclined plane of FIGS. 6 and 7. A single frame period is the continuous exposure time over which any of the entire array of pixels or plate of film is exposed.” *See also* Fig. 8.

80. The ’030 patent discusses how the invention can be practiced, such as by “[m]oving a traditional lens relative to the sensing surface, or changing the lens shape or refractive index, or changing the refractive index of some medium between the lens and sensing surface.” *Id*. at 13:48-57. But importantly, the patent

goes on to say that no matter which of these ways are used, they are all meant to employ a single frame: these "are all ways to change the optical relationship between the lens and the sensing surface so as to maintain the sensing surface at different effective image distances during the imaging of a single scene in a single, continuous exposure of the sensing surface." *Id.*

81. This construction also distinguishes the claims of the '030 patent from the prior art, such as the '045 patent, which took multiple pictures of a scene with different areas in focus and composited them together, such that the final combined image contained the in-focus areas from the source pictures.

B. "During An Exposure Frame Period" (Claim 15)

82. In my opinion, the term "during an exposure frame period" that is found in Claim 15 should be construed as "during the time over which the entire image sensing surface is exposed once."

83. In light of the '030 patent's disclosure, a POSITA would have considered this to be the correct construction for the same reasons as the "continuous exposure frame" that I have discussed above.

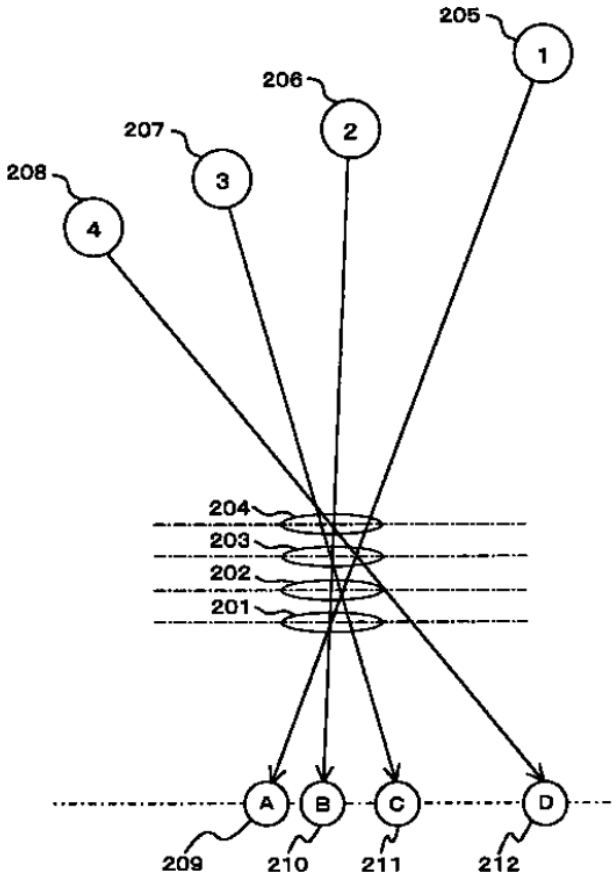
IX. THE PRIOR ART REFERENCES

A. Sugitani

84. The disclosure of *Sugitani* centers around a camera that can take photographs of a variety of objects in a way that ensures all of the objects are in

focus. Ex. 1003, ¶ [0004], Abstract. The *Sugitani* inventors understood that it was well-known at the time to practice certain techniques to keep the entire picture focused, including to reduce the aperture to increase depth of field and to use a tilting lens. *Id*., ¶ [0002]. But the *Sugitani* inventors also understood that there were various known tradeoffs in the prior art, such as the fact that if the aperture is reduced to increase the depth of field, then the shutter speed becomes relatively slower and introduces the risk of blurring, and that advanced technical skill could be required to use a tilting lens. *Id*., ¶ [0003]. To address these tradeoffs, the *Sugitani* inventors came up with a device for manipulating an optical relationship between the camera lens and the image sensor.

85. The operation of *Sugitani's* system can be seen in Fig. 2, copied below:



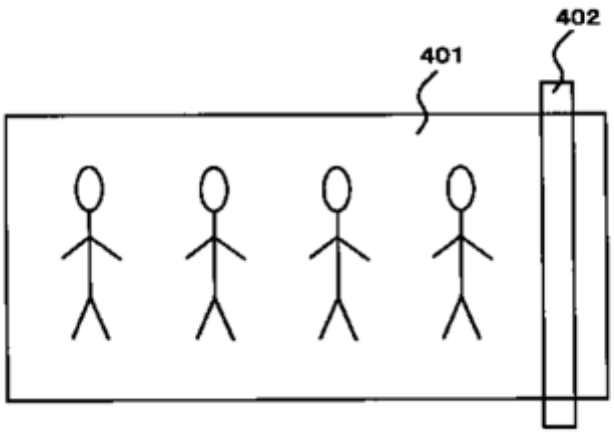
86. Figure 2 shows how the distance between the lens and the exposure surface is modified to bring all of the objects from (205) to (208) into focus. This is done by moving the lens position from 201 to 204. For example, the lens is placed at a position 201 to expose object 205, so that the image is formed at position 209 on the exposure surface. *Id*., ¶ [0014]. The lens is then moved to position 202 in order to expose object 206 at position 210. *Id*. In the same manner, the lens can be moved to positions 203 and 204 so that objects 207 and 208 and are exposed to form images at corresponding positions 211 and 212. *Id*.

87. Notably, these objects are arranged on a line that is perpendicular to the optical axis of the lens in a fashion that the various objects are all able to come into focus while the lens and exposure surface remain parallel. *See id*.

88. According to *Sugitani*, every time the lens is moved, the exposure area needs to be limited. *See id*. at ¶ [0016]. In this manner, the area where the distance is measured can be used as the area where the exposure is performed, and, based on the distance measurement, the lens can be moved. *Id*. ¶ [0017]. This can also be seen in Fig. 4, copied below:

(FIG. 4)

Explanatory diagram of the principles of the present invention (part 3)



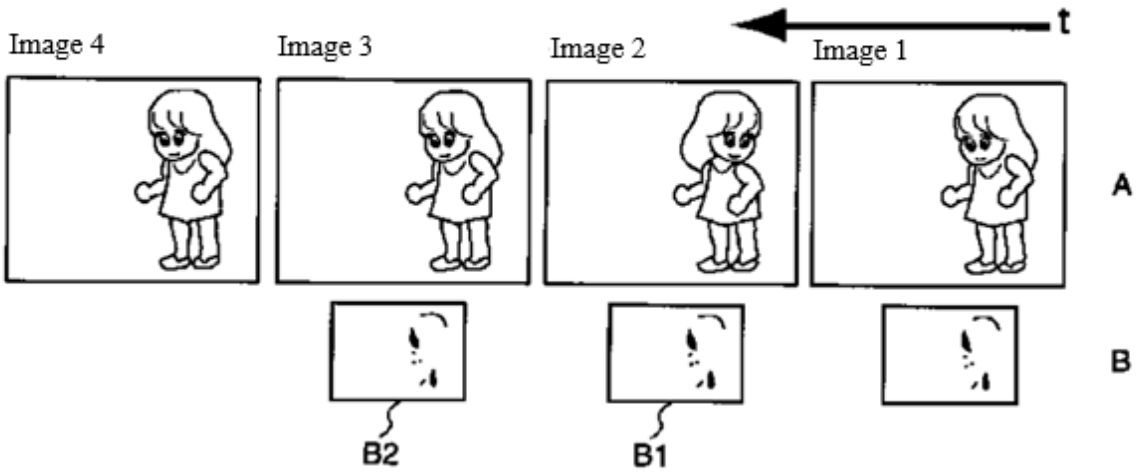
89. As can be seen in Figure 4, while 401 is the entire exposure surface, the exposure area is limited to the area of slit 402. *See id*. Exposure can be performed over the remainder of 401 by moving slit 402 in the left-right direction. *Id*. The area of slit 402 is also used as the distance measurement area. *Id*.

B. Kubo

90. The *Kubo* inventors described a method that served to reduce the motion blur of a digital camera by using the movement of the object to automatically set the appropriate exposure conditions. Ex. 1004, ¶ [0004], Abstract. Put another way, *Kubo* explained how to use the determined movement to vary the exposure period based.

91. Figure 3 of *Kubo*, copied below, shows in situation in which an object engages in a relatively small amount of movement. Images are taken at a predetermined frequency, shown in time from right to left, from image 1 to image 4. *See id*., Fig. 3A-B, ¶ [0037].

(FIG. 3)

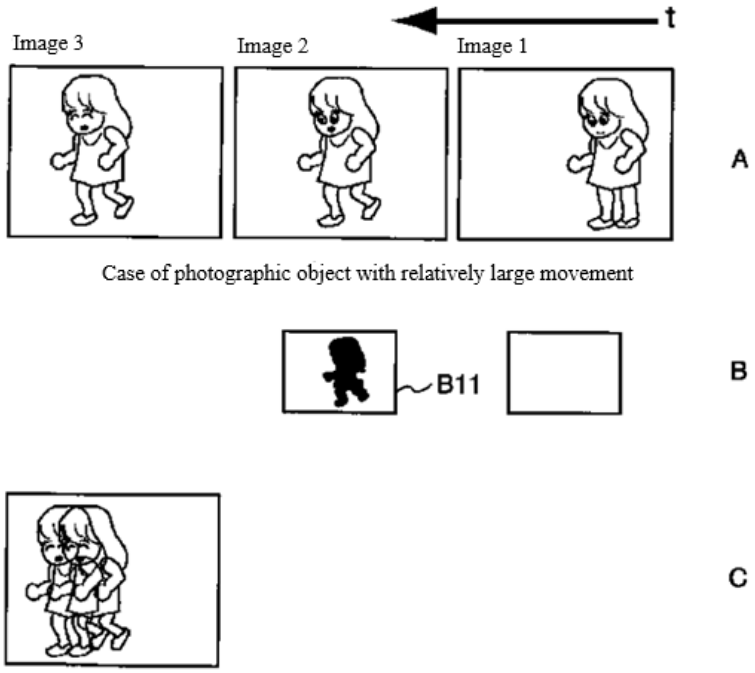


92. *Kubo* compares the difference between the images taken in frames 1 and 2 to obtain data showing the non-correlating portion of the images, which is

called B1. *See id*. Images 2 and 3 are compared in the same way to obtain non-correlating portion data B2. *Id*. *Kubo* then determines if the area ratio of the non-correlating portion data B2 is less than a predetermined percentage, such as 5%. *Id*. If this is the case, the relative movement between the object and the camera is small, which means that a greater aperture value can be applied by using a focal depth priority program line P2. *Id*. This results in a longer exposure time than would be the case using a stationary program with a conventional standard program line P1. *Id.*

93. Figure 4 *Kubo*, copied below, instead looks at the situation where a moving object engages in a relatively large amount of movement. Figure 4A shows images taken of the object, Figure 4B shows the non-correlating portion data calculated by comparing the images, and Figure 4C shows the stationary program exposure using a conventional standard program line P1. *See id*., Fig. 4A-C, ¶ [0035]. Non-correlating portion B11 shown in Figure 4B is examined, and if it is greater than a predefined amount, such as 20%, then the object's movement is large and a shorter exposure time may be employed by using a speed priority program line P3 instead of the standard program line P1. *Id*., ¶ [0040].

(FIG. 4)



94. The *Kubo* inventors also took the brightness of the scene to be photographed into account, such as in the example situation in which the area of non-correlating portion data B2 is less than a predetermined percentage, such as 5%. There, *Kubo* explains that when the object brightness is low, a smaller aperture value can be applied by using the standard program line P1, giving a shorter exposure time than exposure time using the focal depth priority program P2. *See id.*, ¶ [0036]. This is done for similar reasons as the concept of reducing an object with small movement's motion blur. *Id*. On the other hand, if the object brightness is detected to be at a normal or higher than normal amount, *Kubo* can set a shorter than normal exposure time. *Id.*, ¶ [0051].

C. Misawa

95. The *Misawa* inventors discuss using a lens-interchangeable camera to receive "curvature of field information peculiar to [the attached] imaging lens," measure "the contrast of a subject image to detect a focusing position," then "correct[s] the detected focusing position on the basis of the received curvature of field information and generat[es] a control signal for adjusting the focusing position of the subject image formed by the imaging lens," and after that "transmit[] the generated control signal to the lens barrel." Ex. 1005 at Abstract; see also, *e.g.*, *Misawa* ¶¶ [0003-0004], [0052], [0058-0059], [0065], [0067], [0110], [0134], Figs. 2, 5.

96. Petzval surfaces is a term that was coined from the original Hungarian inventor from the early 19th century called Joseph Petzval. Petzval essentially described the optical aberration that emerges when an object (typically flat but not necessarily so) that is normal to the optical axis cannot be brought effectively into focus on a flat image plane. POSITAs were well aware of Petzval surfaces and when looking to address the problems as outlined in *Misawa,* would have readily understood the problems of field of curvature being taught.

97. In other words, *Misawa* discusses how to correct the field curvature of a camera lens and adjust the focusing positions of subject images in great detail. A

POSITA would have understood this discussion to simply be another way of describing the well-known prior art practice of approximating a Petzval surface

D. Berge

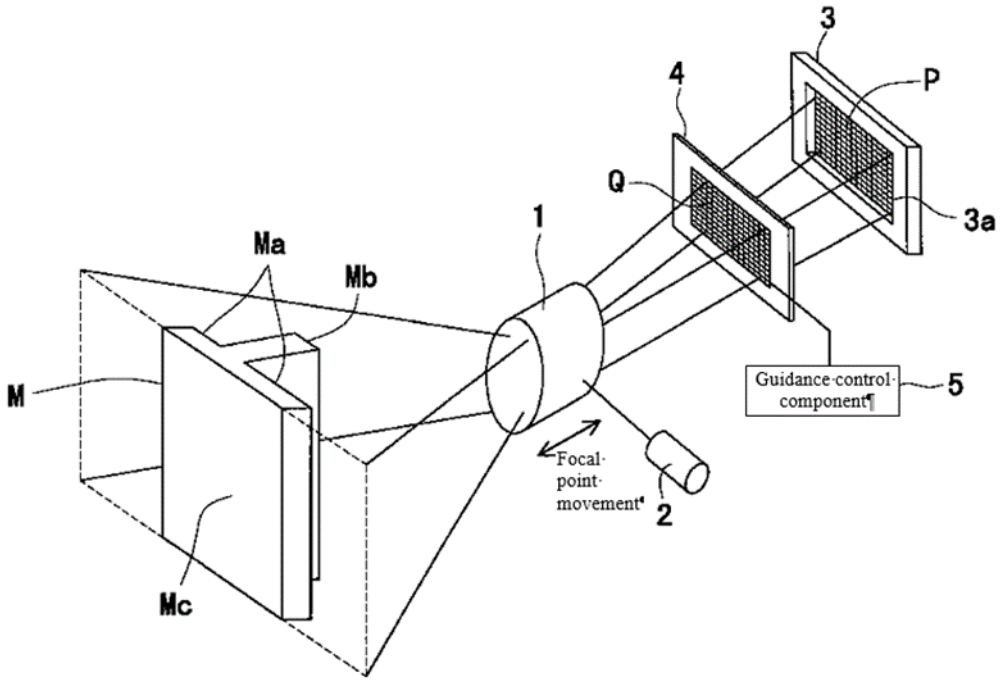
98. The *Berge* inventors discussed how to alter the shape of a lens that is made of a mixture of both insulating and conductive liquids by electrically manipulated the lens different forms. Ex. 1005, Figs. 1-6, 3:18-39, 4:12-15, 39-43, 5:4-7, 24-27, 61-64. According to *Berge*, by using this approach, it is simple to both manufacture and use a lens with a continuously adjustable focus. *Id*. at 1:42-49.

E. Shibata

99. *Shibata* discloses increasing the depth of field of a digital camera while avoiding the need for taking a plurality of photographs to generate a composite image. Ex. 1007, ¶ [0004]. Similar to the '030 patent's teachings, *Shibata* recognizes that the prior disclosed combining a plurality of images with different focal points to create a composite the image with increased depth of field. *Id*., ¶¶ [0003-0004].

100. However, *Shibata* criticizes this technique as time-consuming and requiring linear processing. *Id*., ¶¶ [0003-0004]. *Shibata* describes its disclosed technique as capturing a scene that is entirely in-focus, without requiring multiple photographs or high-capacity image memory. *Id*., ¶ [0006].

101. Like the '030 patent, *Shibata's* disclosed camera has a focal point control component 2 that varies the focal position of a lens 1 during exposure of a single frame. *Id*., Fig. 1 (below), ¶ [0016].



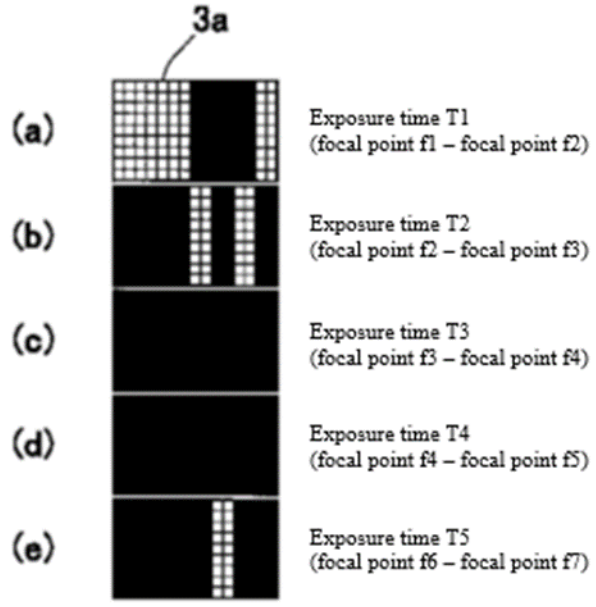
102. The photographic lens 1 captures and forms an optical image of objects M_A and M_B on an imaging element 3. *Id*., ¶ [0017]. The focal point control component 2 serves to variably control the focal point position of the photographic lens 1 within the movable range from one end to the other in the optical route direction. *Id*., ¶ [0018].

103. *Shibata* teaches that the imaging element 3 is a charged-coupled device (CCD that receives the optical image captured by the photographic lens 1,

photoelectrically converts the optical image, and outputs an analog image signal. *Id*., Para. [0019].

104. Fig. 6 of *Shibata* shows the light-receiving face 3a of the CCD. In particular, the white areas of Fig. 6 indicate pixels that are being exposed because they are in a focused state, and black areas indicate pixels not being exposed because they are not in the focused state. *Id*., Fig. 6 (reproduced below), ¶ [0048]. When the focal point position is at f1-f2, the focus is at a distance even with the rear face M_C. *Id*. When the focal point position reaches f1, the shutter elements are controlled in such a way as to start exposure of only those pixels corresponding to the left and right sides of the scene (shown in Fig. 6(a)), which are at the focus distance M_C, and this exposure is continued for a time T1. *Id.*

(FIG. 6)



105. When the focal point position is at f2-f3, the focus is on the M_A. *Id*., ¶ [0049]. When the focal point position progresses and reaches the focal point position f2, the shutter elements are controlled to start exposure of only those pixels corresponding to M_A (shown in Fig. 6(b)), and this exposure is continued for a time T2. *Id*. When the focal point position is at f3-f5, none of the scene is in focus. *Id*., ¶ [0050]. Therefore, when the movement of the focal point position progresses to f3, all shutter elements are set to "obstruct" (shown in Fig. 6(c) and (d)), such that none of the pixels of the CCD 3 are exposed. *Id.*

106. When the focal point position is at f5-f6, the focus is on M_B. *Id*., ¶ [0051]. When the movement of the focal part position reaches f5, the shutter elements start exposure of only those pixels corresponding to M_B (shown in Fig. 6(e)), for a time T5. *Id.*

F. Kondo

107. *Kondo* provides an image pick-up apparatus for obtaining an object of high contrast without losing its detail by varying exposure time for selected pixels. Ex. 1008, ¶¶ [0001], [0007], [0059], [0064].

108. *Kondo* recognized that changing the shutter speed can result in under- or over-exposure such that it is necessary to set exposure time so that the area from the portion where the picture image is most bright up to the portion where it is most dark has suitable brightness. *Id*., ¶ [0003].

109. In conventional digital video cameras, because the same exposure time is generally used with respect to the entirety of the light receiving surface of the CCD, the details of objects can be lost where objects of high contrast are photographed (the bright portion will be overexposed while the dark portion results in underexposure). *Id*., ¶ [0004].

110. *Kondo* therefore proposes a method for varying exposure time with respect to individual pixels based on the amount of light received at each pixel. *Id*., ¶¶ [0006]-[0008]. With reference to Fig. 5 (reproduced below), an evaluating section 23 evaluates pixel values stored in the buffer 21 to deliver its evaluation result to an exposure time determining section 24. *Id*., ¶ [0059].

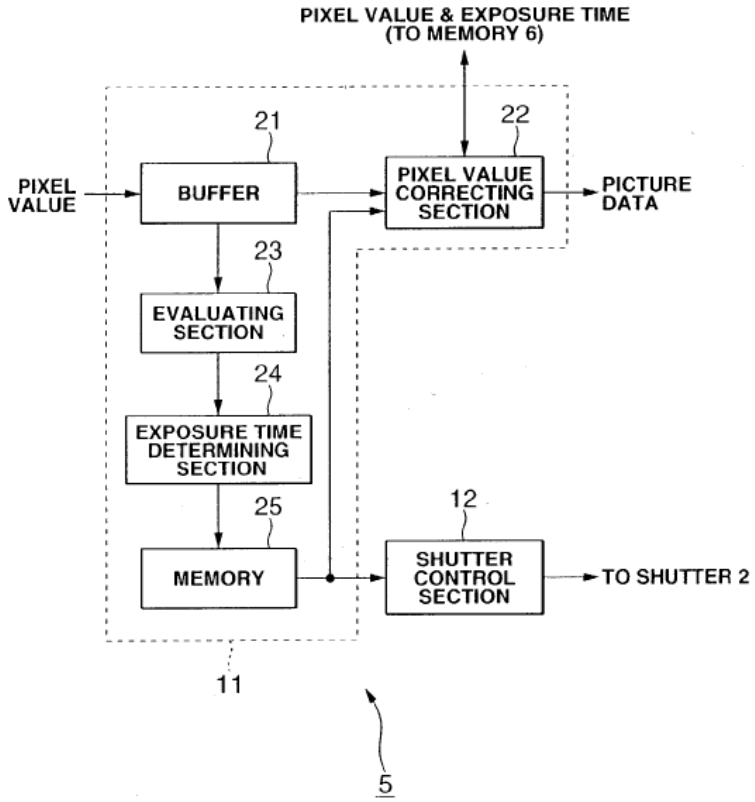


FIG.5

111. The exposure time determining section 24 sets exposure time with respect to the pixel of pixel values stored in the buffer 21 on the basis of the result from the evaluating section 23. *Id*.

112. Specifically, the evaluating section 23 evaluates pixel values stored in the buffer 21 to determine whether the pixel value is above or below a predetermined limit (or similarly movement quantity of the object). *Id*. The exposure time determining section 24 sets exposure time with respect to corresponding pixel values (shorter if the value is above the predetermined limit

and would otherwise result in overexposure; longer if the value is below the predetermined limit and would otherwise result in underexposure). *Id*.

113. *Kondo's* method similarly considers varying exposure time with respect to individual pixels based on the amount of movement detected for each pixel or group thereof. *Id*., Fig. 6, ¶ [0064].

X. MOTIVATION TO COMBINE

A. Sugitani and Kubo

114. In my opinion, a POSITA would have considered it obvious to combine the features of *Kubo* with *Sugitani*.

115. One aspect of *Sugitani* is its discussion of how to expose different portions of an image frame with different image distance or focus corresponding to a variety of different objects in a scene. This is done in order to increase the depth of field and in turn reduce blurring, in the same manner as disclosed in the '030 patent. Another topic discussed in *Sugitani* relates to how reducing the aperture in order to increase the depth of field can introduce the risk of blurring, since the reducing the aperture causes the amount of light available to the sensor to be limited, which in turn necessitates longer shutter speeds. *Sugitani* ¶¶ [0002]-[0003]. I note that *Sugitani* does not expressly recite the details of how to choose exposure settings for an image in order to account for the motion of objects or different lighting conditions. However, this information was readily known and

available in the prior art in references such as *Kubo*. Thus, a POSITA building a complete camera system would be motivated to add the enhanced exposure setting teachings of *Kubo* to the depth of field expansion provided by *Sugitani* to build a fully featured and functional camera.

116. As an amateur photographer in my early career with traditional silver halide photographic film who was taught the basic principles of photography by my family who were professional photographers, I was aware that addressing issues of increasing depth of field under certain exposure and aperture conditions were very well known both generally for POSITAs and also in addition to my own personal experience. In particular, if you are seeking a wide depth of field (*i.e.*, an image with objects at different distances all in focus), that would typically necessitate a smaller aperture (*i.e.*, a larger *f*-number). However, a smaller aperture lets in less light and requires a relatively longer exposure time than a larger aperture. This longer exposure time would increase the risk of blur in moving objects. Thus, POSITA's would know that a photographer would need to balance these competing issues. *Sugitani*'s technique of refocusing during sub-exposures minimizes some of these trade-offs. These issues were and still are critical to create high quality images of the subject and/or object for the photographer. And a POSITA would have been motivated to turn to prior art references, such as *Kubo* as discussed below, to address these issues. And a POSITA would be motivated to

combine *Kubo* and *Sugitani* to limit the tradeoffs otherwise required in seeking wide depth of field.

117. *Kubo* acknowledges that object motion can result in a blurry image, but that this blur can be mitigated and picture quality improved by detecting the object's motion and setting the exposure conditions based on that movement. *See Kubo* at *e.g.*, ¶¶ [0004], [0006], [0010-0012]. A POSITA would have thought to apply this teaching to *Sugitani* in order to improve *Sugitani's* exposure settings for moving objects, at least because that is another photographic condition that must be accounted for independent of how the objects in a scene are arranged. Speed priority has always been a major issue for many photographers, especially for wild-life and sports photography. Improving the quality of a received imaged where the object is in motion has been a challenge for the industry for many years, and a POSITA would have been quite aware of the related issues in being able to achieve this.

118. These considerations would have motivated a POSITA to combine *Sugitani* and *Kubo* so that they could utilize a digital camera that can take into account objects that are arranged at different distances, as well as objects in motion. This would allow them to automatically adjust exposure settings, such as shutter speed, so that an image can be created in which both the focus distance is correctly determined for all of the objects and motion blur is also avoided. A

POSITA would have been aware of the factors that would allow improvement in the quality of an object in motion as this is an important feature for all photographers. Minimizing motion blur through exposure and distance optimization would allow a POSITA to address a common problem in the industry.

119. A POSITA could have readily and predictably made this combination in light of *Kubo's* discussion of the technology needed for distance measuring to determine focus, focusing processing, and exposure control. *See*, *e.g.*, *Kubo* at ¶¶ [0043-0046], Fig. 6. Indeed, the ease of making these sorts of combinations is further evidenced by the disclosure of the '030 patent, which simply describes the functions it envisions and assumes a POSITA could implement those functions without any further detail. This also would have been the case because this was a common problem that a POSITA would have readily seen, and which many photographers faced when suffering motion blur in their image taking.

120. As discussed, *Sugitani* and *Kubo* both recognize that blurring can be avoided based on the exposure setting selection, as well as discuss how to control focus measurement, focusing processing, and exposure selection. Together, this information can be used to predictably improve the quality of images. *Kubo* talks about how to detect object movement and adjust focus and exposure settings to improve the imaging of moving objects. And *Sugitani* talks about separately focusing and exposing different parts of scene to increase the depth of field and so

provide for increased flexibility in aperture selection. Further, a POSITA would have been readily aware of the issues that photographers have in reducing motion blur for moving objects and turned to a reference like *Kubo* to address them.

121. For at least these reasons, a POSITA would be motivated to combine teachings of *Sugitani* and *Kubo*.

B. Misawa, Sugitani and Kubo

122. In my opinion, a POSITA would have considered it obvious to combine the features of *Misawa* with *Sugitani* and *Kubo* in order to achieve the lens advantages taught by *Misawa*.

123. In the Ground 1 analysis of Claim 9 below, I explain in detail that while *Sugitani* describes how to impose an effective curvature to the sensing surface in order to approximate a Petzval surface, *Misawa* provides a detailed implementation describing how to assess and correct effective field curvature

124. A POSITA would have been motivated to combine *Sugitani* with *Misawa* in order to take advantage of the benefits arising from this additional detail. They also would have done so in light of *Misawa's* discussion of how to approximate a Petzval surface on a "lens-interchangeable camera" so that they could take into account the curvature of field information "peculiar to an imaging lens" with a variety of lens. A POSITA would be motivated to produce the highest quality image possible irrespective of camera lens design.

125. Implementing *Misawa's* procedure of how to approximate a Petzval surface in *Sugitani's* system would have been an obvious substitution since both *Sugitani* and *Misawa* involve lens-based cameras and, as just discussed, *Misawa* particularly explains how to compensate for a wide variety of lenses and curvatures. For example, *Sugitani* is expressly directed to obtaining sharp focus of objects obliquely arranged across an image. *See, e.g.*, Fig. 7. Thus, to achieve proper focus, a POSITA would know that Petzval curve related lens distortions, as described in *Misawa*, occur at the edge of an image and need to be corrected. Thus, a POSITA would be motivated to address the quality of image issue that would be affected by an object surface given the background of lenses and Petzval curvature, which is a well-known and common effect.

126. I also note that the Background section of the '030 patent notes that "optical lenses are known to define a Petzval surface or Petzval field curvature as shown in FIG. 5." '030 at 3:36-38. In fact, Figure 5 itself is labeled "prior art." This shows that the '030 patent inventors knew, and that a POSITA also would have been well aware, what the advantages of approximating a Petzval surface were, and would have considered it obvious to achieve them using a technique like *Misawa's*. A POSITA would be motivated to produce the highest quality image possible irrespective of camera lens design using a well-known and common technique such as addressing Petzval curvature.

C. Berge, Sugitani and Kubo

127. In my opinion, a POSITA would have considered it obvious to combine the features of *Berge* with *Sugitani* and *Kubo* in order to achieve the lens advantages taught by *Berge*.

128. The system discussed in *Sugitani* does not depend on lens structure. Rather, *Sugitani* describes how to functionally focus on different objects to achieve the disclosed enhanced depth of field described. How a particular lens needs to be adjusted to achieve focus is merely a routine implementation detail. Thus, and a POSITA would have understood *Sugitani* could accommodate a variety of different lens types. A POSITA would be motivated to produce the highest quality image possible irrespective of camera lens design and structure by addressing a well-known technique such as exposing different portions of an image frame with different image distances or even focusing a variety of different objects in a scene. This together with addressing Petzval curvature would have been obvious for a POSITA to implement without undo experimentation and research.

129. For its part, the light focusing functionality used by *Berge's* liquid lens is that same as what would be used by a traditional glass or plastic lens. *See, e.g., Berge,* 1:6-8, 3:4-6, Fig. 1.

130. Combining *Sugitani* with *Berge* would have been the simple and obvious substitution of one type of lens for another due to the fact that *Sugitani*

only needs the focus to be changed for different objects in the image, without limiting how the lens achieves that focus. While Berge utilizes a liquid lens as opposed to a solid lens, this in itself is nothing extraordinary as optical systems have been using liquid-based organic material lenses since the 1970s when soft human eye contact lenses were first introduced. My first deformable optical lens patent (US Patent No. 5,067,829) was issued on 28th September 1993 that was entitled "Dynamic optical beam steering". While this patent teaches changing an optical beam path using deformable organic-based materials, it does show that the wider concept of using liquid and related organic materials to affect optical effects was well known by the early 1990s.

131. I also note that the '030 patent expressly acknowledges that the invention does not depend on the lens type used. As the patent says: "the effect similar to moving the lens(es) and/or sensing surface, may also be accomplished using a liquid lens or other techniques, where the focal length of the lens itself is changed by changing the shape or refraction index of the optical material of the lens(es)." '030 patent at 13:26-33. This short acknowledgement also shows that a POSITA would have readily been able to substitute of one lens type with another lens type without difficulty.

132. Additionally, I discussed above how the combination of *Sugitani* and *Kubo* teaches how to move a lens to maximize the depth of field. This same

acknowledgement in the ’030 patent confirm that this maximation could also have been accomplished using the liquid lens of *Berge*. A POSITA would have been aware that liquid-based organic material lens were commercially available for decades before the ’030 patent with the known effects of changing or affecting a lens optical property to optimize images with respect to focus and depth of field. A POSITA would have been able to add the teachings of *Berge* to a system like *Sugitani’s* as it was analogous art and reasonably easily to implement.

D. Shibata and Kondo

133. A POSITA would have found it obvious to combine the features of *Kondo* with *Shibata* to maximize picture quality by varying exposure conditions, as highlighted by both references. Specifically, *Kondo* and *Shibata* describe independent, but complementary systems and methods for enhancing picture quality. *Shibata* describes how to change focus during a single exposure frame to make sure all areas of the image are in focus and enhance depth of field. Whereas, *Kondo* describes how to change exposure settings across the frame within a single exposure to enhance dynamic range. Both of these concepts would improve picture quality in different but complementary ways.

134. For example, *Shibata* determines the optimal focal point position of the photographic lens for a particular pixel (or an area including that pixel) by changing the focal point to vary certain exposure conditions. *Shibata* ¶ [0007].

135. *Kondo* similarly varies exposure time with respect to corresponding pixels to provide unity in brightness. *Kondo* ¶¶ [0046], [0059], [0064], [0075].

136. The motivation to combine *Kondo* with *Shibata* is further supported by the fact that both references rely on a liquid crystal shutter to adjust exposure time (to prevent certain portions of the optical image from the lens from reaching a subset of the pixels of the CCD corresponding to shutter elements which are controlled to be closed and to allow other portions of the optical image to reach those pixels which have been controlled to be open). *See*, *e.g.*, *Shibata* ¶ [0022]; *Kondo*, ¶ [0053].

137. A POSITA would understand that the use of the same hardware for a similar purpose is predictable and confirms that the system of *Kondo* can be successfully combined with the system of *Shibata* without requiring undue experimentation. A POSITA would look at the underlying technology such as liquid crystal optical switches and easily have been able to improve the quality of the image through adjustment of exposure and brightness conditions.

138. Finally, a POSITA would also look to both references because each reference addresses similar problems: to maximize the use of memory to avoid creating composite images from a series of planar images. *See*, *e.g.*, *Shibata*, ¶¶ [0004], [0006]; *Kondo*, ¶ [0049].

E. Berge, Shibata and Kondo

139. A POSITA would have found it obvious to combine the features of *Berge* to *Shibata* and *Kondo* to achieve the lens advantages taught by *Berge*. *Shibata* and *Kondo* are combinable for the reasons stated immediately above. The further addition of *Berge* merely relates to a change in lens type. Because the teachings of *Shibata* and *Kondo* do not rely on the types of lens the camera employs, the lens of *Berge* can be used for the benefits it provides without impacting the benefits of depth of field and exposure provided by *Shibata* and *Kondo*, respectively.

140. The systems disclosed by *Shibata* and *Kondo* are not dependent on the lens structure and a POSITA would understand that they could be supported by different lens types. *Berge's* liquid lens provides packaging and control advantages that can be equally employed with the systems of *Shibata* and *Kondo.* A POSITA would have been aware that lens types can vary depending on design and application, but provide similar optical functions needed to improve the quality of an image.

141. The '030 patent expressly admits that the lens type is not relevant to the invention. '030 patent at 13:26-33. And as described above, the combination of *Shibata* and *Kondo* similarly teaches the movement of lenses to maximize depth

of field, which may be similarly accomplished using the liquid lens of *Berge*, as confirmed by the '030 patent.

F. Kubo, Shibata and Kondo

142. A POSITA would have found it obvious to combine the features of *Kubo* with *Shibata* and *Kondo*.

143. As I explained above, a POSITA would have found it obvious to combine *Kondo* and *Shibata* to achieve optimal picture quality by varying exposure conditions.

144. Furthermore, a POSITA would have found it obvious to combine *Kubo* and *Shibata* to optimize the focusing result.

145. As I mentioned above, *Shibata* describes capturing an optical image of multiple objects on an imaging element and variably controlling the focal point position of the photographic lens within the movable range from one end to the other in the optical route direction. *Shibata*, ¶¶ [0017]-[0018]. In other words, *Shibata* describes determining the proper focus position for each of its pixels, which is based on the distance of multiple objects. And as I explain detail in my analysis of Claim 11 below in Ground 6, the combination of *Shibata* and *Kubo* would also have been a readily apparent one to a POSITA for additional reasons. For one, it was well-known in the art to use distance-measuring autofocus or contrast autofocus, or to combine both to achieve the best focus, as shown in prior

art references like U.S. Pub. No. 2003/0081137 to Yamazaki (Ex. 1014). And U.S. Pub. No. 2003/0007076 to Okisu (Ex. 1013) provides a prior art example of how it was well known that camera systems could measure distance to objects to determine focus in multiple ways, and that this determination was simply a design choice.

146. While *Shibata* does not expressly disclose the use of distance measuring sensors to determine focus, *Kubo* teaches the use of distance measuring to determine autofocus control. *Kubo* ¶ [0044], Fig. 6. In other words, *Kubo* teaches measuring distance to the subject independently of the optical system, and subsequently adjusting the optical system for correct focus.

147. A motivation to combine *Shibata*, *Kondo,* and *Kubo* is further supported by the fact that both *Kondo* and *Kubo* describe varying exposure to maximize image quality. *See, e.g*., *Kondo*, ¶¶ [0001], [0007], [0059], [0064]; *Kubo*, ¶ [0004], Abstract; *Shibata*, ¶ [0017]-[0019], [0048], Fig. 6.

XI. CLAIM ANALYSIS

A. Ground 1 – Sugitani and Kubo Render Claims 1-9, 11-21, and 23-24 of the ’030 Patent Obvious

148. In my opinion, the combination of *Sugitani* and *Kubo* discloses Claims 1-9, 11-21, and 23-24.

149. A POSITA would have found it obvious to combine *Sugitani* and *Kubo* for at least the reasons explained in Section X.A above, as well as those discussed in this section.

1. Claim 1

150. In my opinion, the combination of *Sugitani* and *Kubo* discloses Claim 1.

[1-PRE] A method comprising:

151. In the event the claim 1 preamble is considered limiting, *Sugitani* teaches a "method." *See, e.g.*, *Sugitani* Title, Abstract, ¶¶ [0004-0005], [0011-0012], [0023]-[0026].

[1-A] manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens

152. In my opinion, *Sugitani* discloses "manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens."

153. This limitation simply describes the well-known act of focusing a camera system, which *Sugitani* teaches. A POSITA would have been aware that being able to take different portions of an image and improve the quality of that image through improved focus and depth of field would be an obvious approach to increase the overall quality of the whole image.

154. The discussion relating to *Sugitani* Figure 2 shows that this is the case. In this discussion, the *Sugitani* explains that the position of the lens or exposure surface is moved so that "the distance between the lens and the exposure surface is changed." *Sugitani* ¶¶ [0014], [0032], Fig. 2; *see also, e.g.*, ¶¶ [0015], [0030-0031]. This operation in *Sugitani* allows multiple objects arranged at different distances to all come into focus.

155. A POSITA would have thus understood that this movement is a manipulation of the optical relationship between the lens and image sensing surface and a change in their spacing distance.

[1-B] exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods based on detected movement of at least two objects

156. In my opinion, the combination of *Sugitani* and *Kubo* discloses "exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods based on detected movement of at least two objects."

157. In the same manner as discussed in the '030 patent, *Sugitani* explains how to expose different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods.

158. One example in *Sugitani* relates to Figures 2, 3 and 4. *Sugitani* discusses a scenario involving capturing an image of four obliquely-arranged objects, specifically, four people arranged across the image field at different distances from the camera). *Sugitani* ¶¶ [0015]-[0017]. The pictured scene includes a number of sub-regions like areas 305-308, which each have their own different focus distances. *Id*. Slit 402 can be moved in one direction, such as left to right, in order to expose the sensor areas corresponding to each of the different sub-regions while the lens is moved. *Id*. This allows *Sugitani* to acquire proper focus for each person in each sub-region. *Id*.

159. While *Sugitani* explains how each image area is separately exposed, as I have just discussed, *Sugitani* does not expressly explain how to determine the exposure for each sub-region, including how each sub-region is exposed for a different exposure period based on the detected movement of two objects. But a POSITA would have been motivated to apply existing image exposure techniques to each sub-region, since *Sugitani* is exposing a series of different objects in sub-regions across the image field. A POSITA would have been aware that when examining the whole image of an object, different sub-regions would have different characteristics such that one could independently optimize not only the focus of these objects but the exposure of the objects as well. For example, common experience informs anyone who has taken a picture that some objects

being photographed might be well lit while other objects are shadowed (e.g., think of taking the picture of a back lit subject where the background might be properly exposed but the faces of the subject come out shadowed. Spot light metering of subjects within an image was already well-known in the industry to meter for the part of the image of interest. Similarly, it was known to consider the movement of an object selecting exposure characteristics. *See, e.g.*, *Okisu* ¶¶ 96, 97, 126. For a camera like *Sugitani*, which independently exposes each object, the movement and lighting characteristic of each object would naturally be accounted for in each sub image.

160. One of the first things taught to photographers, indeed a fundamental aspect of photography, is how to choose exposure characteristics based on the content of an image field. In fact, early photographers manually improved sub-regions of an image in the dark-room using wet chemical techniques as they knew this would improve the overall quality of the image. Similarly, a basic rule implemented when choosing exposure characteristics is that a camera operator should select shorter exposure periods, using faster shutter speeds, when the object being photographed is moving. This is because the object movement could result in a blurry image if there is a longer exposure period. While a blurring image can be considered detrimental to the final image, in some circumstances, blur adds action to an image. A photographer who specialized in fast motion activity such as

sports or wild-life would be aware of the exposure limitations. A POSITA would have seen these issues and been able to improve the overall image quality through the combination of existing prior art as noted in this declaration.

161. Commercial cameras with shutter priority modes that allowed a photographer to select the exposure period appropriate for objects being photographed were on the market as early as the 1980s. For example, Canon's AE-1 Program camera, which was released in 1981, included shutter priority modes and also automatically selected the corresponding aperture required to obtain a proper exposure. *See* https://global.canon/en/c-museum/product/film103.html. I certainly utilized this feature early in my experience as an amateur photographer.

162. A POSITA would have been motivated to incorporate prior art automated exposure systems that account for object movement, such as the system taught by *Kubo*, into *Sugitani* at least due to this well-known need to account for object movement in selecting exposure characteristics.

163. A method for varying exposure based on detected object movement in described in *Kubo*. The process showing in *Kubo's* Figures 3A and 3B shows how to detect the degree of an object's movement by analyzing the degree of non-correlation between two rapidly captured images. *Kubo* ¶ [0038]. *Kubo* also goes on to discuss how to use this detected movement to determine the "exposure

period." *Kubo* ¶¶ [0038]-[0040]. In particular, a small degree of movement permits an increased exposure time, while a large degree of movement calls for a shorter exposure time. *Id*.

164. A POSITA would have readily applied *Kubo's* exposure time calculation technique to each of the sub-exposures discussed in *Sugitani* because *Sugitani* teaches how to expose each of the objects in its image field in sub-exposure regions with different focuses in order to achieve a superior overall image. A POSITA would have also been aware that to improve an image quality, then improving the exposures would generally benefit the whole image.

165. As noted above, *Sugitani* discloses that in a scene with four people, all four will be exposed at different times with different focal distances. Accordingly, applying *Kubo's* exposure time calculation technique to each of the four people in *Sugitani's* example exposure would involve calculating based on the movement of each person independently. As a result, the motion and brightness of each of the four people, which are the claimed "at least two objects," affect the adaptive exposure, as claimed. A POSITA would have been able to easily implement these teachings as it would have improved the whole image quality, which is something the POSITA would be aiming to do.

2. Claim 2: The method of claim 1, wherein the image sensing surface comprises an array of photosensitive pixels

166. In my opinion, both *Sugitani* and *Kubo* disclose that the claimed image sensing array comprises "an array of photosensitive pixels."

167. The *Sugitani* exposure surface can be a "CCD of a digital camera." *Sugitani* ¶ [0027]. This would have commonly been understood to mean an array of photosensitive pixels. POSITAs were well aware of CCD technology, which was comprised of photosensitive pixels, as this technology was first developed in the 1970s, and became popular in the 1980s through the efforts of at least companies such as Kodak Inc.

168. For its part, *Kubo* explains that its: "imaging unit 4 comprises solid state imaging elements (light receiving units) arrayed in a matrix and a charge transfer unit, and constitutes a single plate type area sensor in which transparent filters for the three primary colors are arranged in pixel units." *Kubo* ¶¶ [0005], [0017].

3. Claim 3: A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens; and exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods based on detected brightness of at least two objects.

169. In my opinion, the combination of *Sugitani* and *Kubo* discloses Claim 3.

170. Claim 3 is an independent claim that differs from Claim 1 by changing the word "movement" to "brightness" as shown in the comparison below.

CLAIM 1	CLAIM 3
1. A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens; and exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods based on detected movement of at least two objects.	**3**. A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens; and exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods based on detected brightness of at least two objects.

171. Accordingly, for all of the reasons I discussed above for Claim 1, *Sugitani* discloses every aspect of Claim 3, including how to take a series of sub-exposures, each with a different focus distance appropriate for the object in the sub-image, other than this "brightness" concept. However, this concept is simply a recitation of the well-known process for selecting the exposure characteristics for an image, or sub-image, based on the brightness of objects in the scene.

172. As was the case for object motion (as discussed above), it was long known to account for object brightness when determining exposure periods. In fact, it was commonplace for object brightness to be the input value used to calculate the exposure period, as controlled by the shutter speed. It was commonly understood that a longer exposure period will be required for a darker object to acquire a properly exposed image, while a reduced amount of time is needed for a brighter object.

173. For at least these reasons, a POSITA would have been motivated to incorporate automated exposure systems that account for object brightness, like the *Kubo* system, into the *Sugitani* camera.

174. *Kubo* provides a representative disclosure of this common concept. In *Kubo*, detected brightness is used to select exposure period, with the period being increased when the object's detected brightness is low, or instead increased when the object's detected brightness is high. *See*, *e.g.*, *Kubo* ¶¶ [0011], [0036], [0051-0052]. *Kubo* Figure 8, copied below, similarly shows how different programs can be used to select shutter speed in light of the detected brightness.

Fig. 8

THE RATIO OF THE NON-CORRELATED AREA	THE BRIGHTNESS OF THE SUBJECT	SELECTED PROGRAM CHARACTERISTIC		
		DEPTH PRIORITY PROGRAM	STANDARD PROGRAM	SPEED PRIORITY PROGRAM
LESS THAN 5%	NORMAL BRIGHTNESS	○		
	LOW BRIGHTNESS		○	
NOT LESS THAN 5%	NORMAL BRIGHTNESS		○	
	LOW BRIGHTNESS		○	
NOT LESS THAN 20%	NORMAL BRIGHTNESS			○
	LOW BRIGHTNESS		○	

175. A POSITA would have been motivated to apply *Kubo's* exposure time calculation technique to *Sugitani's* detected objects separately because *Sugitani* teaches separately adjusting the exposure of each object to achieve the best result in terms of the quality of the overall image. A POSITA would have been aware that optimizing exposure would add to the improvement of the image quality, and so naturally would have seen the use of *Kubo's* technique as a way of achieving *Sugitani's* goal of improving imagine quality.

176. As noted above, *Sugitani's* method does not expose each of the four people in the scene simultaneously, but rather independently exposes each portion of the sensor that corresponds to each person is independently, at a different time and at a different focal distance. This allows the POSITA to increase the quality of the image using standard optimization techniques available in the late 1990s.

177. This means that the application of *Kubo's* exposure time calculation technique to the separate exposures of each of the four people in the *Sugitani* example, which are the claimed "at least two objects," would result in the calculation of the exposure based on the brightness of at least two objects, as claimed. Thus, a POSITA would have been aware that this would improve the overall image quality and further advanced that goal of *Sugitani*.

4. Claim 4

178. In my opinion, *Sugitani* discloses Claim 4.

> **[4-PRE] and [4-A]: A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens**

179. Claim 4 is an independent claim with the same preamble and Element [1-A] as Claim 1.

180. Accordingly, it is my opinion that these aspects of Claim 4 are disclosed by *Sugitani* for the same reasons I explained in those sections above.

[4-Additional Elements] exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein the image sensing surface comprises an array of pixels in adjacent rows, wherein a first portion of the array is exposed while the image sensing surface is at a first effective image distance, and a second portion of the array is exposed while the sensing surface is at a second effective image distance, and wherein at least one pixel of the first portion is in a same row of the array as at least one pixel of the second portion

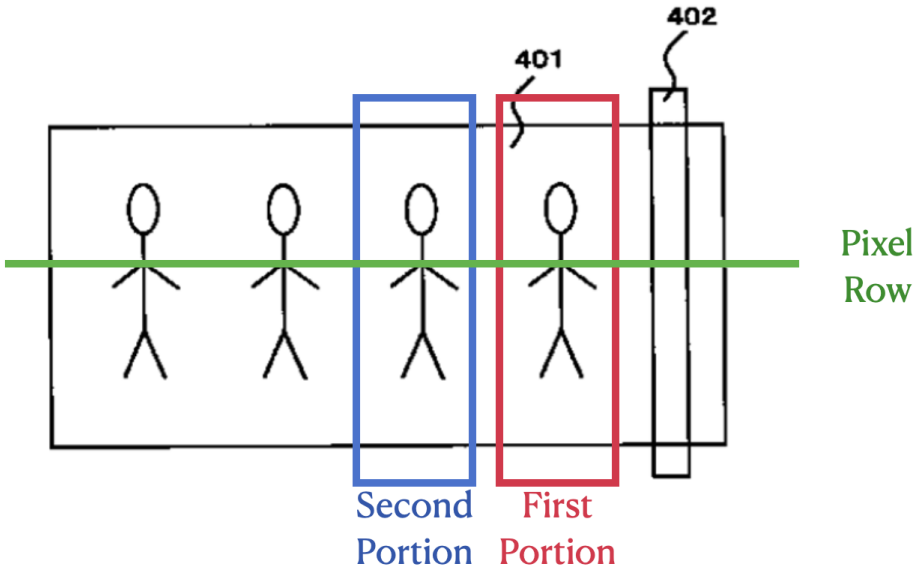
181. It is my opinion that *Sugitani* also discloses the above-recited additional elements of Claim 4.

182. With respect to Claim 2 above, I have already explained how *Sugitani* and *Kubo* disclose an exposure surface comprising an array of photosensitive pixels.

183. And as I also explained with respect to Claim Elements [1-A] and [1-B] above, *Sugitani* also discloses how to create multiple sub-exposures of an exposure surface, by having each sub-exposure capture a different object at a different focus distance, or "effective image distance." This changes the spacing between the lens and the exposure surface.

184. This can be considered with reference to *Sugitani* Figure 4, which is copied and annotated below. One example of how *Sugitani* discloses the aspect of Claim 4 stating that "a first portion of the array is exposed while the image sensing surface is at a first effective image distance" is seen with respect to the red box, which indicates the time at which a first person is placed in focus and the image is

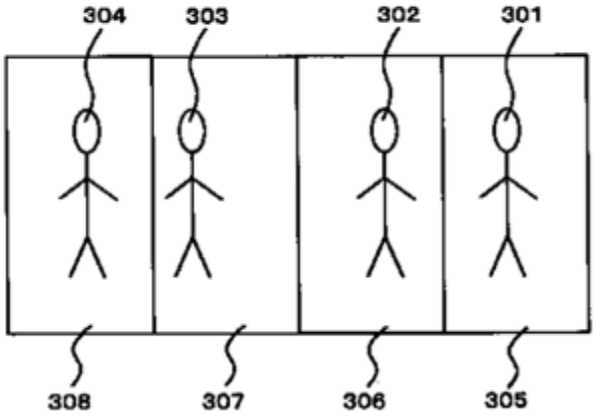
exposed. Similarly, an example of how *Sugitani* discloses the aspect of Claim 4 stating that "a second portion of the array is exposed while the sensing surface is at a second effective image distance" is seen with respect to the blue box, which indicates the time at which a second person is placed in focus and the image is again exposed.



185. *Sugitani* also expressly notes that the exemplary four different portions of the exposure surface, areas 305-308, are arranged horizontally, and also shows such a horizontal arrangement in Figure 3, copied below. *Sugitani* ¶¶ [0015-0016].

(FIG. 3)

Explanatory diagram of the principles of the present invention (part 2)



186. Accordingly, the pixels of the exposure surface in each of the four different exposure areas are in the same row of the array, as also indicated by the green line in the annotated version of Figure 4 above. *See also Sugitani* ¶¶ [0016]-[0017].

5. Claim 5: The method of claim 4, wherein at least one of manipulating the optical relationship and exposing different portions of the image sensing surface are adaptive to objects in a scene to be imaged at the sensing surface.

187. In my opinion, *Sugitani* discloses "wherein at least one of manipulating the optical relationship and exposing different portions of the image sensing surface are adaptive to objects in a scene to be imaged at the sensing surface."

188. An example of how is seen in *Sugitani's* discussion relating to Figure 6. This discussion explains how: 1) first, slit 402 is positioned over a portion of the exposure surface; 2) next, the distance to the object in that object field is

measured; and 3) then "driving of the lens is performed on the basis of results of distance measurement." *Sugitani* ¶¶ [0023]-[0024].

189. Put more simply, *Sugitani* explains how the way that the optical lens is driven and optical relationship is affected in order to achieve focus is adaptive to the distance measured to the objects in the scene.

6. Claim 6: The method of claim 4, wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions based on at least a detected first and second object distance.

190. In my opinion, *Sugitani* discloses "wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions based on at least a detected first and second object distance."

191. This is shown by way of *Sugitani's* teaching of moving the slit that exposes portions of the exposure surface to the position currently in focus. *Sugitani* ¶ [0018] (discussing moving "slit 506 to the exposure position in focus" so "an image of the object is formed on the exposure surface"). And the position in focus is dictated by the measured distance to an object obtained from autofocus sensor 501. *Id.*

192. Particularly in light of *Sugitani*'s repeated disclosures regarding moving the lens and slit to focus on multiple objects, a POSITA would understand that this adaptive exposure of portions of the exposure surface would be performed on the basis of the distance to more than one object. *Id.* ¶¶ [0017], [0024]-[0025].

And as I discussed about for Claim 3, a POSITA would have been aware that optimizing exposure would add to the improvement of the image quality.

7. Claim 7: The method of claim 4, wherein manipulating the optical relationship comprises manipulating between a first effective image distance and a second effective image distance, wherein the first and second effective image distances correspond respectively to the first and second object distances.

193. In my opinion, *Sugitani* discloses "wherein manipulating the optical relationship comprises manipulating between a first effective image distance and a second effective image distance, wherein the first and second effective image distances correspond respectively to the first and second object distances."

194. As I explained above with respect to Claims 4 and 5, *Sugitani* determines what positions to move the lens to, including the claimed first and second effective image distances, based on the measurements to different objects, such as persons 301-304, that it obtains. *Sugitani* ¶¶ [0016]-[0017], [0023]-[0024].

8. Claim 8: The method of claim 4, wherein manipulating the optical relationship comprises moving at least one of the lens and the sensing surface relative to one another.

195. In my opinion, *Sugitani* discloses "wherein manipulating the optical relationship comprises moving at least one of the lens and the sensing surface relative to one another."

196. In fact, *Sugitani* discloses this claim in both possible ways: 1) moving the lens relative to the exposure surface; and 2) moving the exposure surface and fixing the lens. *Sugitani* ¶¶ [0014]-[0017], [0031].

9. Claim 9

197. In my opinion, *Sugitani* discloses Claim 9.

> **[9-PRE] and [9-A]: A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens**

198. Claim 9 is an independent claim with the same preamble and Element [1-A] as Claim 1.

199. Accordingly, it is my opinion that these aspects of Claim 9 are disclosed by *Sugitani* for the same reasons I explained in those sections above.

> **[9-B] exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein manipulating the optical relationship synchronously with exposing operates to impose an effective curvature to the sensing surface that approximates a Petzval surface**

200. In my opinion, *Sugitani* discloses "exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein manipulating the optical relationship synchronously with exposing operates to impose an effective curvature to the sensing surface that approximates a Petzval surface."

201. As I discussed above in detail for Claim Elements [1-A] and [1-B], *Sugitani* discloses how to expose different portions of an exposure surface alongside changing the "effective image distance" spacing between a lens and an exposure surface.

202. Additionally, *Sugitani* teaches imposing an effective curvature that approximates a Petzval surface. By way of background, with respect to certain lenses, objects across the entirety of a frame may not be in focus if adjustments are not made. For example, if an object in the center of a frame is in focus, objects that are at the same distance from the camera, but are instead at the edges of the frame, will not be in focus absent adjustment, as the focus for objects farther away from the center of the frame will be at distances closer to the camera.

203. This concept was well known at the time of the '030 patent. In fact, Figure 5 of the patent, which is copied below and illustrates this principle, is labeled as "prior art."

204. The known solution for lenses with this issue was to adjust the optical relationship between lens and the image sensor in order to achieve proper focus for objects at the edges of the image. This is the case even if objects at the center of the frame and objects at the edge of the frame are at the same distance from the camera. Adjusting for these differences in the optical relationship was commonly known as approximating a Petzval surface.

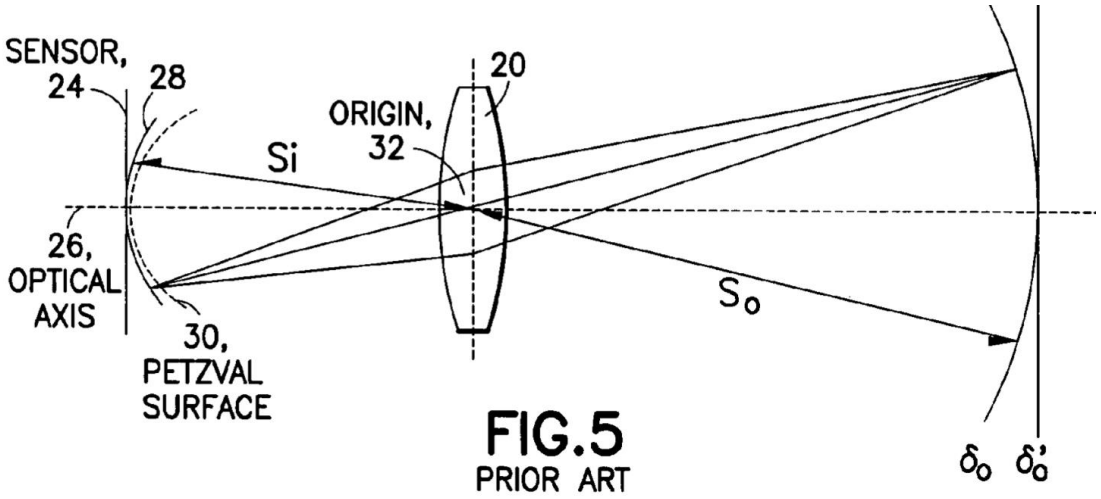


FIG.5
PRIOR ART

205. *Sugitani* achieves the proper focus for objects at the edge of the scene according to their distance because, as I have discussed above for Claim 1, *Sugitani* adjusts the focus for each sub-region of an image, which separately accounts for objects at the center of the frame and at the edges. In other words, *Sugitani* minimizes the loss of focus around the edges of the frame by serially focusing the lens on discrete portions of the image field. This minimizes the loss of focus around the edges of the frame.

206. *Sugitani* thus approximates a Petzval surface. A POSITA would have been aware that optimizing focus within the overall image would add to the improvement of the image quality in a manner that approximates a Petzval surface, and in doing so further *Sugitani's* goal of improving image quality.

10. Claim 11

207. In my opinion, *Sugitani* discloses Claim 1.

[11-PRE], [11-A], and [11-B]: A method comprising: determining a first object distance between a first object in a scene and a lens; determining a second object distance between a second object in the scene and the lens

208. Claim 11 is an independent claim with the same preamble as Claim 1. Accordingly, it is my opinion that this of Claim 11 is disclosed by *Sugitani* for the same reasons I explained in that section above.

209. In my opinion, *Sugitani* also discloses both "determining a first object distance between a first object in a scene and a lens," and also doing the same for a second object.

210. For example, in reference to Claim 6, *Sugitani* explains that the distance to the object is measured in step 603. *Sugitani* ¶ [0024]. And as explained in detail for the following limitations of this claim, this step is repeated for each object in the scene, meaning that the distance is determined for both a first and second object. *See also, e.g.*, *id*. ¶¶ [0024-0026].

[11-C] and [11-D]: within a continuous exposure frame: exposing a first portion of an image sensing surface while the image sensing surface is at a first effective image distance from the lens, where the first effective image distance corresponds to the first object distance, exposing a second portion of the image sensing surface while the image sensing surface is at a second effective image distance from the lens, where the second effective image distance corresponds to the second object distance; and combining the exposed first and second portions into a single image

211. In my opinion, *Sugitani* also discloses "within a continuous exposure frame: exposing a first portion of an image sensing surface while the image sensing surface is at a first effective image distance from the lens, where the first effective image distance corresponds to the first object distance" and also "exposing a second portion of the image sensing surface while the image sensing surface is at a second effective image distance from the lens, where the second effective image distance corresponds to the second object distance; and combining the exposed first and second portions into a single image."

212. This is my opinion both under a plain meaning claim construction, and also under the proposed construction of "within a continuous exposure frame" as "within the period from the start of an exposure of the imaging sensing surface until the entire image sensing surface is exposed once" that I discussed above in Section VIII.A.

213. To start, with reference to Figure 6, *Sugitani* explains how the lens is driven to a position based on the object distance in step 604 and the corresponding portion of exposure surface is then exposed in step 605. *Sugitani* ¶ [0024]. According to *Sugitani*, the distance measurement area and exposure slit are then moved, and the above driving and exposure steps are then repeated. *Id.* ¶¶ [0025]-[0026]. This causes a second portion of the exposure surface to be exposed, at a

time when the lens has been positioned in a second position based on the distance to the second object. *Id.* ¶¶ [0025]-[0026].

214. *Sugitani* also makes clear that each of the lens, distance measurement area, and slit can be moved continuously during a single exposure, meaning that all are moved within the same continuous exposure frame. *Id.* ¶ [0024].

215. It is also explained in *Sugitani* that the exposed first and second exposed portions that I discussed above are combined into a single image. Or to put it in *Sugitani's* words, its focus-by-portion method "makes it possible to take a photograph such that the entire surface of the exposure surface 401 is in focus." *Id.* ¶ [0017].

11. Claim 12: The method of claim 11, wherein the single image is displayed on a digital graphical user interface

216. In my opinion, the combination of *Sugitani* and *Kubo* discloses "wherein the single image is displayed on a digital graphical user interface."

217. While *Sugitani* explains that its camera has a digital display, it does not explicitly disclose that captured images that it captures are displayed on it. *Sugitani* ¶¶ [0017], [0024], [0027]. However, it was well known to use the display on a digital camera to display captured images by the June 2005 priority date of the '030 patent. My first digital camera, which was actually made by Canon in the 1990s, displayed captured images. While this particular camera may not have been the earliest CCD or CMOS imager chip, my personal experience is consistent with

the fact that a POSITA would have been well aware of this feature. Indeed, digital cameras were ubiquitous by 2005, especially with the growing popularity of CMOS image chips (over CCDs) that helped in part to bring the cost of these products down competitively and opened the market to consumer buyers globally.

218. One of many such prior art digital cameras is *Kubo*, which expressly discloses that its monitor 10 displays images as they are taken. *Kubo* ¶¶ [0044-0045]. As shown in *Kubo*, the ability to instantly preview images was a key and heavily desired feature of digital cameras, to the extent that a POSITA would have expected *Sugitani*'s display could display the images its camera captured. This immediate checking on an image changed the perception of users (consumers) who used cameras to take images as they did not have to wait days, if not weeks for images to return from wet chemical processing facilities. At the time, in the 1990s, it was termed unofficially as 'instant gratification' with subjects running up to the photographer to see what the image looked like immediately after the image was taken. At a minimum, a POSITA would have found it obvious to modify *Sugitani* to include this feature from *Kubo* for the same reasons. A POSITA would have been aware that previewing images would shorten the timely feedback of the image to the camera operator and add to the improvement of the image quality, and a POSITA would have been motivated to enjoy these benefits.

12. Claim 13: The method of claim 11, wherein exposing the first and second portion of the image sensing Surface comprises adaptively exposing said portions for a first and second exposure time based on a detected brightness of the first and second objects.

219. Claim 13 requires that "exposing the first and second portion of the image sensing surface comprises adaptively exposing said portions for a first and second exposure time based on a detected brightness of the first and second objects." This language is the same as Claim Element [3-B].

220. Accordingly, in my opinion, the combination of *Sugitani* and *Kubo* discloses Claim 13 for the same reasons I explained in that section above.

13. Claim 14: The method of claim 11, wherein exposing the first and second portion of the image sensing Surface comprises adaptively exposing said portions for a first and second exposure time based on a detected speed of movement of the first and second objects.

221. Claim 14 requires that "wherein exposing the first and second portion of the image sensing surface comprises adaptively exposing said portions for a first and second exposure time based on a detected speed of movement of the first and second objects." This language is the same as Claim Element [1-B].

222. Accordingly, in my opinion, the combination of *Sugitani* and *Kubo* discloses Claim 14 for the same reasons I explained in that section above.

14. Claim 15

223. In my opinion, *Sugitani* and *Kubo* discloses Claim 15.

[15-PRE]: A memory storing a program of machine-readable instructions, executable by a digital data processor, to perform actions directed toward operating a camera, the actions comprising:

224. In my opinion, *Sugitani* discloses "a memory storing a program of machine-readable instructions, executable by a digital data processor, to perform actions directed toward operating a camera."

225. An example of this can be seen in the discussion regarding *Sugitani's* Figure 5, which explains that its sub-frame focus and exposure method are carried out by a CPU 502 executing program code stored in ROM 510 of the camera. *Sugitani* ¶¶ [0019],[0023], Figure 5.

[15-A]: during an exposure frame period, maintaining an image sensing surface at a variable effective image distance from a lens synchronously with exposing different portions of the sensing surface, wherein the image sensing surface comprises an array of photosensitive pixels

226. In my opinion, *Sugitani* discloses "during an exposure frame period, maintaining an image sensing surface at a variable effective image distance from a lens synchronously with exposing different portions of the sensing surface, wherein the image sensing surface comprises an array of photosensitive pixels."

227. This is my opinion both under a plain meaning claim construction, and also under the proposed construction of "during an exposure frame period" as "during the time over which the entire image sensing surface is exposed once" that I discussed above in Section VIII.B.

228. As I have previously explained, *Sugitani's* programming adjusts the lens position relative to the exposure surface and simultaneously adjusts the portion of the exposure surface being exposed by moving a slit over the course of an exposure period of one frame. *Sugitani* ¶¶ [0014], [0015], [0017], [0024]-[0027].

229. And I explained above for Claim 2, *Sugitani*'s CCD exposure surface is an array of photosensitive pixels. *See, e.g.*, *Sugitani* ¶ [0027].

15. Claim 16: The memory of claim 15, wherein at least one of maintaining the image sensing surface at a variable effective image distance and exposing different portions of the image sensing surface are adaptive to objects in a scene to be imaged at the sensing surface.

230. Claim 16 recites the same language as Claim 5.

231. Accordingly, in my opinion, *Sugitani* discloses Claim 16 for the same reasons I explained above for Claim 5.

16. Claim 17: The memory of claim 15, wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions based on at least a detected first and second object distance.

232. Claim 17 recites the same language as Claim 6.

233. Accordingly, in my opinion, *Sugitani* discloses Claim 17 for the same reasons I explained above for Claim 6.

17. Claim 18: The memory of claim 15, wherein maintaining an image sensing surface at a variable effective image distance comprises varying between a first and a second image distance

that respectively correspond to the first and second object distances.

234. Claim 18 recites the same language as Claim 7.

235. Accordingly, in my opinion, *Sugitani* discloses Claim 18 for the same reasons I explained above for Claim 7.

18. Claim 19: The memory of claim 15, wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions for different exposure periods based on detected movement of at least two objects.

236. Claim 19 recites the same requirement pertaining to adaptively exposing portions of the surface based on detected movement as Claim Element [1-B].

237. Accordingly, in my opinion, the combination of *Sugitani* and *Kubo* discloses Claim 19 for the same reasons I explained above for Claim Element [1-B].

19. Claim 20: The memory of claim 15, wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions for different exposure periods based on detected brightness of at least two objects.

238. Claim 20 recites the same requirement pertaining to adaptively exposing portions of the surface based on detected brightness as Claim Element [3-B].

239. Accordingly, in my opinion, the combination of *Sugitani* and *Kubo* discloses Claim 20 for the same reasons I explained above for Claim Element [3-B].

20. Claim 21: The memory of claim 15, wherein the program controls exposure of the photosensitive pixels according to rows.

240. In my opinion, *Sugitani* discloses that "the program controls exposure of photosensitive pixels according to rows."

241. As I discussed above for Claim 2, Sugitani discloses a CCD exposure surface that is an array of pixels, which includes rows of pixels. *See*, *e.g.*, *Sugitani* ¶ [0027].

242. The movement of *Sugitani's* slit during the focus-by-portion method I have discussed throughout the ground is explained to be able to be performed either horizontally, which would control exposure according to columns, or vertically, which would control exposure according to rows. *Sugitani* ¶¶ [0030], Figures 8 and 9.

21. Claim 23: The memory of claim 15, wherein maintaining an image sensing surface at a variable effective image distance synchronously with exposing operates to impose an effective curvature to the sensing surface that approximates a Petzval surface.

243. Claim 23 recites the same language as Claim 9.

244. Accordingly, in my opinion, *Sugitani* discloses Claim 23 for the same reasons I explained above for Claim 9.

22. Claim 24: The memory of claim 15, wherein maintaining the image sensing surface at a variable effective image distance from the lens comprises moving the lens relative to the sensing surface.

245. In my opinion, *Sugitani* discloses "maintaining the image sensing surface at a variable effective image distance from the lens comprises moving the lens relative to the sensing surface."

246. As I explained above for Claim 8, *Sugitani* discloses both moving the lens and moving the surface. *See, e.g.*, *Sugitani* ¶¶ [0014]-[0017], [0031]. Thus, *Sugitani* discloses Claim 24 by way of the discussion relating to moving the lens.

B. Ground 2 – Sugitani, Kubo, and Misawa Render Claims 9 and 23 of the '030 Patent Obvious

247. In my opinion, the combination of *Sugitani*, *Kubo*, and *Misawa* discloses Claims 9 and 23.

248. A POSITA would have found it obvious to combine *Sugitani*, *Kubo*, and *Misawa* for at least the reasons explained in Section X.B above, as well as those discussed in this section.

1. Claim 9

249. In my opinion, the combination of *Sugitani*, *Kubo*, and *Misawa* discloses Claim 9.

[9-PRE] and [9-A]: A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens

250. Claim 9 is an independent claim with the same preamble and first element as Element [1-A] as Claim 1.

251. Accordingly, it is my opinion that these aspects of Claim 9 are disclosed by *Sugitani* for the same reasons I explained above in Ground 1 with regard to Elements [1-PRE] and [1-A].

[9-B] exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein manipulating the optical relationship synchronously with exposing operates to impose an effective curvature to the sensing surface that approximates a Petzval surface

252. As discussed above in the analysis of Claim 9 in Ground 1, it is my opinion that *Sugitani* discloses "wherein manipulating the optical relationship synchronously with exposing operates to impose an effective curvature to the sensing surface that approximates a Petzval surface."

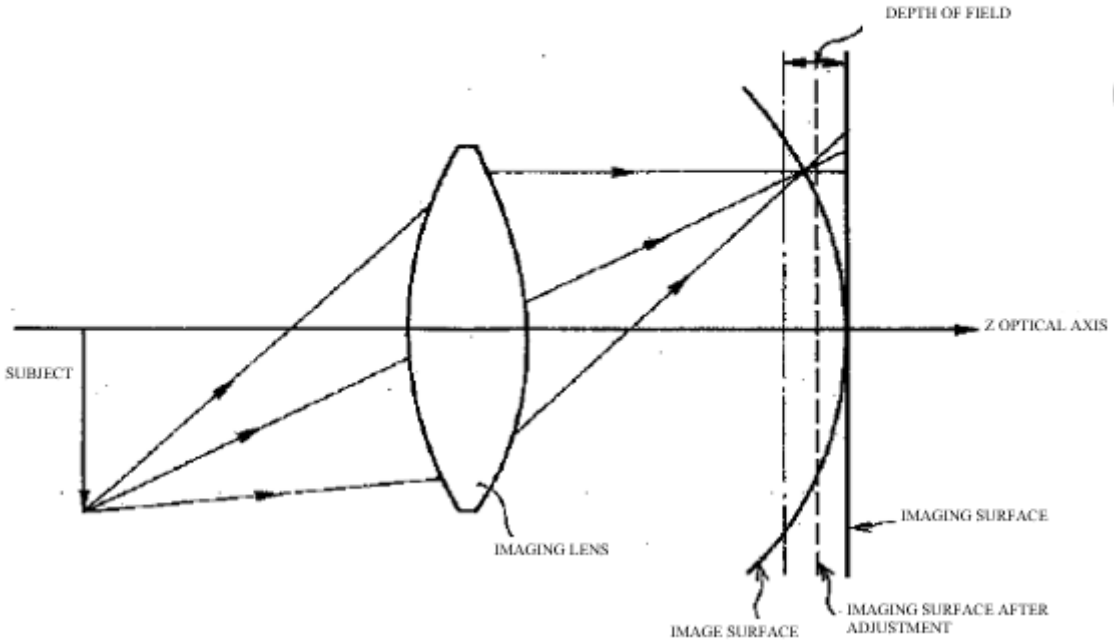
253. However, in the event that *Sugitani* is found not to have disclosed this element, it is my opinion that *Misawa* provides a detailed disclosure that satisfies this element and would motivate a POSITA to add approximating a Petzval surface to *Sugitani*.

254. One focus of *Misawa* was to provide a solution to a problem in the prior art that had prevented the focusing position for in image that was out of focus from being corrected at the time of image processing. *Misawa* ¶¶ [0003-0004]; *see also* Abstract, ¶ [0052]. *Misawa* addressed this problem by focusing on the time of imaging and obtaining a camera lens's unique curvature of field of information and position adjustment information at that point. *Id*.

255. By doing so, *Misawa* provided a way of measuring the "relationship between the distance from the optical axis and the image surface or the position of the imaging surface to be adjusted," and adjusting the focus of the image based on the measured distance. *Id*. ¶¶ [0059], [0065], [0115], Fig. 5.

256. Figure 2, which is copied below, also shows the relationship between the imaging surface and the adjustment that *Misawa* makes to it. *See also id*., ¶ [0065].

(FIG. 2)



257. This adjustment that *Misawa* performs is a disclosure of approximating a Petzval surface, as claimed.

2. Claim 23: The memory of claim 15, wherein maintaining an image sensing surface at a variable effective image distance synchronously with exposing operates to impose an effective curvature to the sensing surface that approximates a Petzval surface.

258. As explained above in the analysis of Claim 15 in Ground 1, *Sugitani* discloses the limitations of independent claim 15.

259. As also discussed above in the analysis of Claim 9 in Ground 1, it is my opinion that *Sugitani* discloses "wherein manipulating the optical relationship synchronously with exposing operates to impose an effective curvature to the

sensing surface that approximates a Petzval surface," which is the same language as in Claim 23.

260. However, in the event that *Sugitani* is found not to have disclosed this language, it is my opinion that *Misawa* provides a more detailed disclosure of it that also satisfies this Claim, for the same reasons discussed above for Claim 9.

C. Ground 3 – Sugitani, Kubo, and Berge Render Claims 10 and 25 of the '030 Patent Obvious

261. In my opinion, the combination of *Sugitani*, *Kubo*, and *Berge* discloses Claims 10 and 25.

262. A POSITA would have found it obvious to combine *Sugitani*, *Kubo*, and *Berge* for at least the reasons explained in Section X.C above, above, as well as those discussed in this section.

1. Claim 10

263. In my opinion, the combination of *Sugitani*, *Kubo*, and *Berge* discloses Claim 10.

> **[10-PRE] and [10-A]: A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens**

264. Claim 10 is an independent claim with the same preamble and first element as Element [1-A] as Claim 1.

265. Accordingly, it is my opinion that these aspects of Claim 10 are disclosed by *Sugitani* for the same reasons I explained above in Ground 1 with regard to Elements [1-PRE] and [1-A].

[10-B]: exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein manipulating the optical relationship comprises altering a shape of the lens.

266. In my opinion, the combination of *Sugitani* and *Kubo* discloses "exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein manipulating the optical relationship comprises altering a shape of the lens."

267. There is no express disclosure in *Sugitani* regarding manipulating the optical relationship by altering a shape of the lens, for example by using a liquid lens that achieves focus by changing shape. However, *Sugitani* does not say that its teachings are limited to any particular type of lens. In fact, the real focus of *Sugitani* is adjusting focus based on object position, which is not something that depends on any particular lens type. *See, e.g.*, *Sugitani* ¶ [0006].

268. Many different types of lenses, including lenses that changed focus by changing their shape, were well known in the prior art. Materials such as organics were utilized at least as early as the 1970s to manipulate and change optical effects of lenses, and a POSITA would have been well aware of these effects and conditions prior to the invention of the '030 patent. Further, a POSITA would

have been easily able to, and would have been motivated to, apply *Sugitani's* teaching to cameras with shape altering lenses to achieve the known benefits of shape altering lenses. A POSITA would have been aware that optimizing lens effects would add to the improvement of the image quality, which would have furthered *Sugitani's* goal of doing the same.

269. One such reference that a POSITA would have found it obvious to combine *Sugitani* with is *Berge*. *Berge* teaches a variable focus lens that can have its shape altered using by electrically manipulating a mixture of insulating and conductive liquids into different forms and thereby alter the shape of the lens. *Berge* at FIGS. 1-6, 3:18-39, 4:12-15, 39-43, 5:4-7, 24-27, 61-64.

270. *Berge's* technique provides for a lens that is both simple to manufacture and use, and also has a continuously adjustable focus. *Id*. at 1:42-49. It also increases the durability and longevity of the focusing mechanism by avoiding the need to have moving parts in focusing. A POSITA would have been aware that optimizing focus would add to the improvement of the image quality, and so would have been motivated to use *Berge's* technique to achieve *Sugitani's* goal of improved image quality.

2. Claim 25: The memory of claim 15, wherein maintaining the image sensing surface at a variable effective image distance from the lens comprises changing a shape of the lens.

271. As explained above in the analysis of Claim 15 in Ground 1, *Sugitani* discloses the limitations of independent claim 15.

272. Claim 25 additionally recites the same requirement pertaining to altering the shape of the lens as Claim Element [10-B].

273. Accordingly, in my opinion, the combination of *Sugitani*, *Kubo*, and *Berge* discloses this requirement for the same reasons I explained above for Claim Element [10-B].

D. Ground 4 – Shibata and Kondo Render Claims 1-5, 7-9, 15-16, and 18-24 of the '030 Patent Obvious

274. In my opinion, the combination of *Shibata* and *Kondo* discloses Claims 1-5, 7-9, 15-16, and 18-24.

275. A POSITA would have found it obvious to combine *Shibata* and *Kondo* for at least the reasons explained in Section X.D above, above, as well as those discussed in this section.

1. Claim 1

276. In my opinion, the combination of *Shibata* and *Kondo* discloses Claim 1.

[1-PRE] A method comprising:

277. It is my opinion that while "a method" in claim 1's preamble should not be limiting, Shibata discloses a "method." *See, e.g., Shibata* ¶ [0025], Fig. 4.

[1-A] manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens

278. It is my opinion that *Shibata* discloses this claim limitation.

279. It is my opinion that this claim limitation describes the well-known act of focusing a camera system. The '030 patent illustrates this in the Background section. '030 Pat at 1:45-51 ("FIG. 2A is similar to FIG. 1, but with the lens 20 moved so that an object at a distance So<<∞ (e.g., less than about 20') is instead focused on the sensor 24. The focal length f has not changed between FIGS. 1 and 2A; it is set by the shape and refractive index of the lens 20. Movement of the lens 20 or sensor 24 enables focusing of non-parallel incoming light rays 22 at the sensor 24…"); *compare* Figs. 1 and 2A (labeled "PRIOR ART").

280. In my opinion, *Shibata* discloses this limitation through a "focal point control component 2" that adjusts the position of "photographic lens 1." *Shibata* ¶¶ [0017]-[0018], Fig. 1.

281. Specifically, *Shibata* explains that the focal point is serially repositioned to obtain focus on the entire subject scene during image capture. *Id.* ¶ [0046] ("while moving the focal point position, for each pixel P of the CCD 3,

when the focal point position reaches the aforesaid designated focal point position, the shutter element Q of the aforesaid liquid crystal shutter 4 corresponding to that pixel P is opened and set to the 'guide' state"); *see also* ¶¶ [0036]-[0051], Figs. 4-6.

[1-B] exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods based on detected movement of at least two objects

282. In my opinion, *Shibata* combined with *Kondo* discloses this claim limitation.

283. It is my opinion that *Shibata* teaches exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods, as disclosed and claimed in the '030 patent.

284. As one example, with respect to Figs. 5 and 6, *Shibata* explains that a shutter elements Q, including a liquid crystal shutter 4, is used to obstruct exposure to pixels on Shibata's image sensing surface (CCD 3). Shibata ¶¶ [0048]-[0051]. It is my opinion that Shibata's shutter element Q operates to only expose those pixels that are in focus based on the position of lens 1 such that when lens 1 is repositioned, shutter elements Q adapts to obscure pixels that are not in focus and

expose the pixels that are in focus. *Id*., *see also id.* Fig. 6 (showing different obstruction and exposure of pixels at various focal points).

285. In my opinion, *Shibata* also describes that its pixels are separately exposed at various focal points and that the duration of each exposure is calibrated based on the detected illuminance distribution of the object detected during a preliminary analysis. *Shibata* ¶¶ [0013], [0032], [0042], [0055].

286. In my opinion, while *Shibata* recognizes that exposure characteristics can be set to correspond to the specific conditions of each sub-image, *Shibata* does not expressly disclose calibrating the exposure period based on the detected movement of two objects.

287. But in my opinion, because *Shibata* exposes a series of independent-sub images across the image field, a person of skill in the art would be motivated to apply existing image exposure techniques to each of those sub images. A POSITA would have been aware that when examining the whole image of an object, different sub-regions would have different characteristics such that one could independently optimize not only the focus of these objects but the exposure of the objects as well. For example, common experience informs anyone who has taken a picture that some objects being photographed might be well lit while other objects are shadowed (e.g., think of taking the picture of a back lit subject where the background might be properly exposed but the faces of the subject come out

shadowed. Spot light metering of subjects within an image was already well-known in the industry to meter for the part of the image of interest. Similarly, it was known to consider the movement of an object selecting exposure characteristics. *See, e.g., Okisu* ¶¶ 96, 97, 126. For a camera like *Shibata*, which independently exposes each object, the movement and lighting characteristic of each object would naturally be accounted for in each sub image.

288. It is also my opinion that it was well-known that exposure periods should be adapted to account for the movement of the object being photographed to prevent blurriness. When the shutter is open longer, anything that moves in the frame during that time gets blurrier. Choosing exposure characteristics based on the content of an image field is thus a fundamental aspect of photography and one of the first thing taught to photographers. A POSITA would have been aware that optimizing exposure characteristics would add to the improvement of the image quality. I certainly learnt these affects early in my amateur photography work in the 1970s. In fact, in the 1970s, Canon had started developing FD-series lens supporting auto-exposure control system, as well as shutter speed-priority auto-exposure, aperture-priority auto-exposure, and program auto-exposure. *See* https://global.canon/en/c-museum/history/story05.html. Indeed, shutter speed priority auto-exposure allows the user to choose a specific shutter speed while the camera adjusts the aperture to ensure correct exposure. Aperture-priority auto-

exposure allows the user picks an aperture with the camera selecting the shutter speed to match. Program auto-exposure allows the camera to select both. All of them simplify and optimize exposure characteristics and improve image quality.

289. It was well-known that a fast shutter speed creates a shorter exposure—the amount of light the camera takes in—and a slow shutter speed gives the photographer a longer exposure. And one of basic rules of choosing exposure characteristics is that a camera operator should select shorter exposure periods (*i.e.*, faster shutter speeds) when the object being photographed is moving because a longer exposure period will result in a blurry image due to object movement. A POSITA would have been aware that optimizing exposure characteristics would add to the improvement of the image quality.

290. As an example, starting in the 1980s, film cameras such as Canon's AE-1 Program (released in 1981) included shutter speed priority system that electronically controlled the aperture opening for the given shutter speed to ensure the optimum exposure. The shutter speed priority modes allowed a photographer to select the exposure period appropriate for objects being photographed, while the camera automatically selected the corresponding aperture required to obtain a proper exposure. In other words, Canon AE-1's shutter speed priority system allowed a user to control image blur at will and to emphasize the movement of the subject. A POSITA would have been aware that optimizing motion characteristics

would add to the improvement of the image quality, such as using a faster shutter speed to capture fast-moving subjects with minimal or no motion blur, or using slower shutter speeds to capture motion blur to enhance the action in photos.

291. In my opinion, based on this well-known need to account for object movement in selecting exposure characteristics, a POSITA seeking to implement the teachings of *Shibata* in a camera would be motivated to incorporate the automated exposure systems that account for object movement, such as the system taught by *Kondo*.

292. In my opinion, *Kondo* teaches a method for varying exposure based on detected brightness that shares some commonality *Shibata*—pixel brightness values are analyzed to determine if exposure duration should be adjusted. *Kondo* ¶¶ [0059], [0064]. But *Kondo* adds the additional advantage that pixels are analyzed across frames to detect movement quantity and further calibrate the exposure duration to, *e.g.*, reduce duration in situations where large amounts of movement are detected. *Id.*

293. In my opinion, a POSITA would recognize that *Shibata's* and *Kondo's* teachings are not limited to photographing a single object. It is my opinion that although Shibata refers to photographing "the subject" in the singular, a POSITA would understand that *Shibata* uses "subject" to refer to the entire scene of the photograph without regard to how many different objects are in the scene

and without any intent to limit *Shibata's* method to only photographing single objects. A POSITA would have been aware that optimizing multiple objects would add to the improvement of the image quality. And as I explained above, at least by late 1990's, it was well-known to capture multiple subjects, including small subjects located in the periphery, using cameras like the Nikon F5 that supported multiple exposures. *See* http://www.mir.com.my/rb/photography/hardwares/classics/NikonF5/metering/. In this context, a POSITA would have understood that *Shibata* and *Kondo* disclose photographing multiple objects.

294. Additionally, it is my opinion that both *Shibata* and *Kondo* analyze the imaging field on the basis of pixels, and their processes therefore make no distinction on the numbers of objects in the picture. For example, *Kondo's* movement detection method operates by comparing 3x3 grids of pixels across frames, without regard to whether those pixels correspond to one object or several objects. *Kondo* ¶ [0064].

295. In my opinion, for at least the reasons discussed above, a POSITA would understand that implementing *Shibata's* teachings combined with *Kondo's* teachings regarding adjusting exposure based on movement detection would understand (or at least find it obvious) that the method would adjust exposure based on the movement of at least two objects, as claimed.

296. It is also my opinion that the combination of *Shibata* and *Kondo* would be readily implemented because both *Shibata* and *Kondo* disclose liquid crystal shutters that can be controlled at the pixel level to selectively expose only discrete portions of the sensor beneath. *See, e.g.*, *Shibata* ¶¶ [0044-0047], Fig. 6; *Kondo* ¶¶ [0051-0053], Fig. 3.

2. Claim 2: The method of claim 1, wherein the image sensing surface comprises an array of photosensitive pixels

297. Claim 2 depends on Claim 1 and requires that the claimed image sensing array comprises "an array of photosensitive pixels."

298. In my opinion, *Shibata* teaches this claim limitation because it discloses a "CCD 3 [that] consists of m × n pixels P comprising light-receiving elements arrayed in a matrix of n rows and m columns." *Shibata* ¶ [0019].

299. It is also my opinion that *Kondo* teaches this limitation because it discloses a CCD comprised of pixels. *See, e.g., Kondo* ¶ [0045]. A CCD imager consists of a large number of light-sensing elements arranged in a two-dimensional array on a thin silicon substrate. Since first introduced commercially, CCDs have typically been configured with square pixels assembled into rectangular area arrays, with an aspect ratio of 4:3 being most common. A POSITA thus would have understood that these pixels would have been arranged in an array, as that was the conventional way of doing so.

3. Claim 3: A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens; and exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods based on detected brightness of at least two objects.

300. Claim 3 is an independent claim that differs from Claim 1 by changing the word "movement" to "brightness" as shown in the comparison below.

CLAIM 1	CLAIM 3
1. A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens; and exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods based on detected movement of at least two objects.	**3**. A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens; and exposing different portions of the image sensing surface synchronous with manipulating the optical relationship by adaptively exposing said portions for different exposure periods based on detected brightness of at least two objects.

301. In my opinion, *Shibata* discloses Claim 3.

302. All aspects of Claim 3 other than the change to "brightness" are thus discussed above for Claim 1.

303. As I explained in Element [1-B], *Shibata* teaches adjusting the exposure times based on the detected illuminance of pixels to account for uneven distribution of illuminance. *Shibata* ¶¶ [0013], [0032], [0042], [0055].

304. While *Shibata's* description is directed to an example where different object faces of the physically contiguous subject M being photographed, in my

opinion, a POSITA would understand that the faces of M have different focus distances and different illuminance characteristics and could be considered different "objects".

305. It is also my opinion that a POSITA would readily recognize that *Shibata's* method for detecting brightness and adjusting exposure times accordingly would be equally applicable to photographing multiple objects, as claimed. A POSITA would have been aware that optimizing brightness and exposure would add to the improvement of the image quality.

4. Claim 4

306. In my opinion, *Shibata* discloses Claim 4.

> **[4-PRE] and [4-A]: A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens**

307. Claim 4 is an independent claim with the same preamble and Element [1-A] as Claim 1. Thus, those portions of clam 4 are taught by *Shibata* for the same reasons set forth above. *See* Paragraphs 277-281, *supra*.

> **[4-Additional Elements] exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein the image sensing surface comprises an array of pixels in adjacent rows, wherein a first portion of the array is exposed while the image sensing surface is at a first effective image distance, and a second portion of the array is exposed while the sensing surface is at a second effective image distance, and wherein at least**

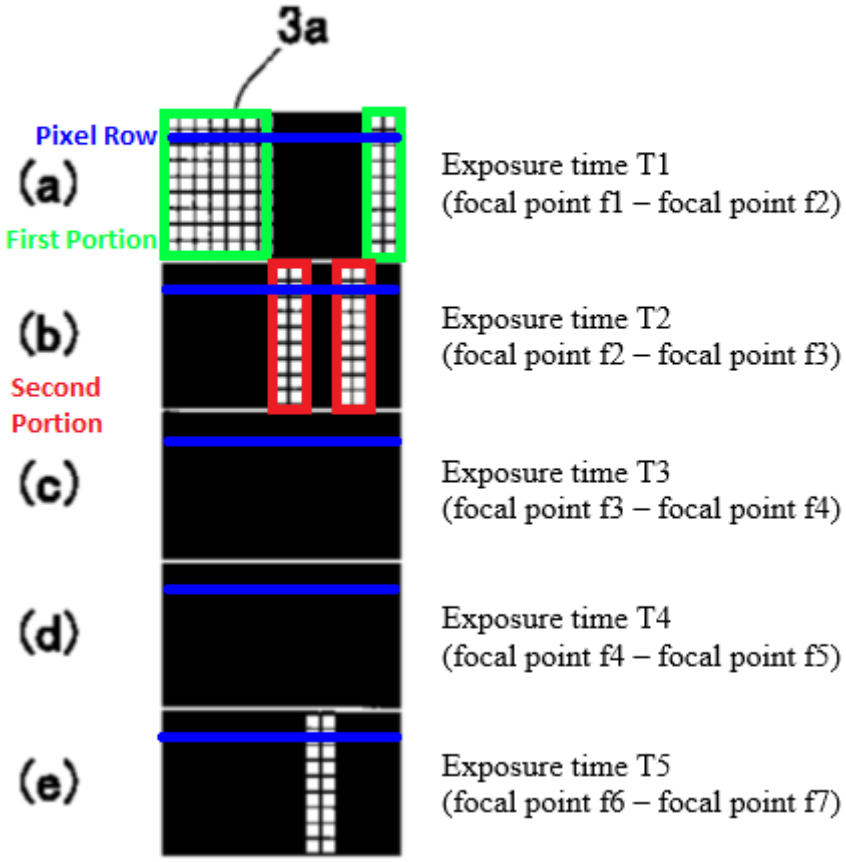
one pixel of the first portion is in a same row of the array as at least one pixel of the second portion

308. It is my opinion that *Shibata* also discloses the additional elements of Claim 4.

309. As I explained above for Claim 2, *Shibata* teaches an exposure surface comprising an array of photosensitive pixels. And as explained above for Elements [1-A] and [1-B], *Shibata* teaches exposing different groups of pixel P at different "effective image distance" (i.e., the focus distance), which changes spacing between the lens and exposure surface.

310. In my opinion, as shown in the annotated version of Fig. 6 (below), *Shibata* discloses "a first portion of the array is exposed while the image sensing surface is at a first effective image distance," wherein, for example, at stage (a), only the portions of the image sensing surface shown as white pixels (green) are exposed when the lens is positioned between focal points f1 and f2, and at stage (b), different portions of the surface (red) are exposed as the lens repositions between focal points f2 and f3:

(FIG. 6)



311. In my opinion, *Shibata* also discloses that the different portions of the exposure surface are arranged horizontally. Thus, pixels within the different portions are in the same row of the array (*see* blue pixel row shown at each exposure stage above). *Shibata* ¶¶ [0048]-[0051], Fig. 6.

5. Claim 5: The method of claim 4, wherein at least one of manipulating the optical relationship and exposing different portions of the image sensing surface are adaptive to objects in a scene to be imaged at the sensing surface.

312. Claim 5 depends from Claim 4 and additionally requires that "wherein at least one of manipulating the optical relationship and exposing different portions of the image sensing surface are adaptive to objects in a scene to be imaged at the sensing surface."

313. In my opinion, *Shibata* discloses both manipulating the optical relationship and exposing different portions of the image sensing surface based on objects in the scene.

314. First, it is my opinion that *Shibata's* method involves a preliminary photography stage in which the image is sampled multiple times while the lens is positioned at each available focal point. *Shibata* ¶¶ [0035]-[0037]. Second, *Shibata's* camera then analyzes the sampled image data to determine what focal point achieved focus for each pixel of the exposure surface, and stores that data in RAM. *Id.* ¶¶ [0008], [0038].

315. It is my opinion that *Shibata*'s image data is then used by a guidance control component 5 during the main photography stage to control shutter elements Q and only expose pixels when the lens is positioned at those pixels corresponding focal point. *Shibata* ¶¶ [0024], [0031], [0046]-[0047].

316. In my opinion, the shape and distance of the objects being photographed as described in *Shibata* will dictate both the focal point (i.e. optical relationship), exposed pixels (portions), and the correspondence between the two.

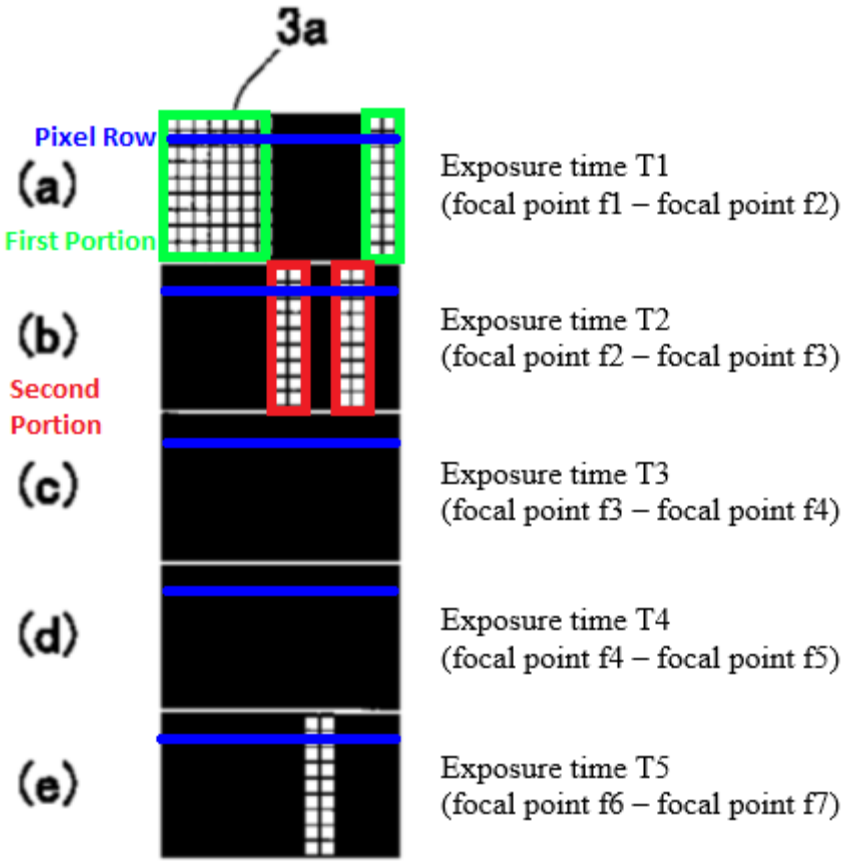
6. Claim 7: The method of claim 4, wherein manipulating the optical relationship comprises manipulating between a first effective image distance and a second effective image distance, wherein the first and second effective image distances correspond respectively to the first and second object distances.

317. Claim 7 depends from Claim 4 and additionally requires "wherein manipulating the optical relationship comprises manipulating between a first effective image distance and a second effective image distance, wherein the first and second effective image distances correspond respectively to the first and second object distances."

318. As I explained above for claims 4 and 5, *Shibata* discloses this claim limitation because it teaches that the lens moves to different positions (*i.e.*, the first and second effective image distances) such that each pixel of the frame (including those pixels corresponding to first and second objects) will be in focus. *Shibata* ¶¶ [0017], [0024]-[0025]. A POSITA thus would have been aware that moving a lens to different positions to capture objects at different distances would optimize exposure for focus and so contribute to the improvement of *Shibata's* image quality.

319. For example, in the below annotated Fig. 6, the red outlined pixels corresponding to focal points f2 through f3 might depict two similarly distant people being photographed, whereas the green portions corresponding to focal points f1 through f2 might depict trees in the background at a greater distance:

(FIG. 6)



320. It is my opinion that the movement of the focal point between those two positions ("effective image distances") corresponds to the respective first and second distances to the trees and people.

7. Claim 8: The method of claim 4, wherein manipulating the optical relationship comprises moving at least one of the lens and the sensing surface relative to one another.

321. Claim 8 depends from Claim 4 and additionally requires "wherein manipulating the optical relationship comprises moving at least one of the lens and the sensing surface relative to one another."

322. In my opinion, *Shibata* discloses the dependent limitations of claim 8. *Shibata* discloses focal point control component 2 that moves the lens relative to the image sensing surface in performing *Shibata's* method. *Shibata* ¶¶ [0017], [0039].

8. Claim 9

323. In my opinion, *Shibata* discloses Claim 9.

[9-PRE] and [9-A]: A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens

324. Claim 9 is an independent claim with the same preamble and Element [1-A] as Claim 1. *Shibata* teaches those elements for the same reasons set forth above regarding Claim 1.

[9-B] exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein manipulating the optical relationship synchronously with exposing operates to impose an effective curvature to the sensing surface that approximates a Petzval surface

325. Claim 9 additionally requires "exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein manipulating the optical relationship synchronously with exposing operates to impose an effective curvature to the sensing surface that approximates a Petzval surface."

326. As I explained above for Elements [1-A] and [1-B], *Shibata* teaches exposing different sets of pixels (i.e., portions of exposure surface) in conjunction with the changing of the "effective image distance" spacing between the lens and exposure surface.

327. It is my opinion that *Shibata* also teaches imposing an effective curvature that approximates a Petzval surface. For some lenses, if an object in the center of a frame is in focus, then objects the same distance from the camera, but at the edges of the frame, will not be in focus. The '030 patent illustrates this known concept in Fig. 5 (labeled prior art). For such lenses, to achieve proper focus for objects at the edges of the image, the optical relationship between lens and the image sensor will need to be adjusted, even if the objects at the edge of the frame are at the same distance from the camera as the objects at the center of the frame. Making these adjustments for objects at the edges of the frame will approximate a Petzval surface.

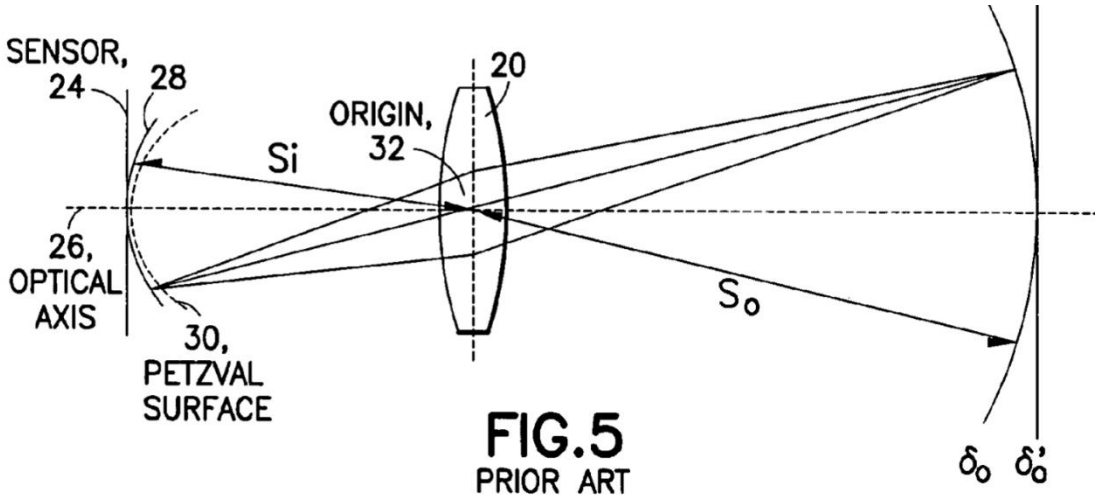


FIG.5
PRIOR ART

328. In my opinion, because *Shibata* only exposes pixels when the lens is positioned such that those pixels will be in focus, it will achieve proper focus for objects at the edge of the scene according to their distance and, thereby, approximate a Petzval surface. A POSITA would have been aware that optimizing focus would add to the improvement of the image quality.

329. Put it differently, exposing on a Petzval surface minimizes the loss of focus around the edges of the frame, which is precisely what *Shibata* accomplishes by only exposing portions of the image field when the lens is positioned to put them in focus. *Id*.

9. Claim 15

330. In my opinion, *Shibata* discloses Claim 15.

> **[15-PRE]: A memory storing a program of machine-readable instructions, executable by a digital data processor, to perform actions directed toward operating a camera, the actions comprising:**

331. Claim 15's preamble requires "A memory storing a program of machine-readable instructions, executable by a digital data processor, to perform actions directed toward operating a camera."

332. In my opinion, *Shibata* teaches that its sub-frame focus and exposure method is carried out by a CPU 11 executing program code stored in ROM 13 of the camera. *Shibata* ¶¶ [0032]-[0033], FIG. 3.

[15-A]: during an exposure frame period, maintaining an image sensing surface at a variable effective image distance from a lens synchronously with exposing different portions of the sensing surface, wherein the image sensing surface comprises an array of photosensitive pixels

333. Claim 15 next requires code that "during an exposure frame period, maintaining an image sensing surface at a variable effective image distance from a lens synchronously with exposing different portions of the sensing surface, wherein the image sensing surface comprises an array of photosensitive pixels.

334. In my opinion, *Shibata* discloses these limitations.

335. This is my opinion both under a plain meaning claim construction, and also under the proposed construction of "during an exposure frame period" as "during the time over which the entire image sensing surface is exposed once" that I discussed above in Section VIII.B.

336. As I explained above, *Shibata*'s programming adjusts the lens position relative to the exposure surface and simultaneously adjusts the portion of pixels on

the exposure surface being exposed during an exposure period of one frame by use of a liquid crystal shutter 4 and shutter elements Q. *Shibata* ¶¶ [0044]-[0051]. *Shibata*'s CCD exposure surface is an array of photosensitive pixels. *See* claim 2.

10. Claim 16: The memory of claim 15, wherein at least one of maintaining the image sensing surface at a variable effective image distance and exposing different portions of the image sensing surface are adaptive to objects in a scene to be imaged at the sensing surface.

337. Claim 16 depends from Claim 15 and additionally adds the same requirements set forth in Claim 5.

338. In my opinion, *Shibata* teaches the dependent limitations of Claim 16 for the same reasons set forth above with regard to Claim 5.

11. Claim 18: The memory of claim 15, wherein maintaining an image sensing surface at a variable effective image distance comprises varying between a first and a second image distance that respectively correspond to the first and second object distances.

339. Claim 18 depends from Claim 15 and additionally adds the same requirements set forth in Claim 7.

340. In my opinion, *Shibata* teaches the dependent limitations of Claim 18 for the same reasons set forth above with regard to Claim 7.

12. Claim 19: The memory of claim 15, wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions for different exposure periods based on detected movement of at least two objects.

341. Claim 19 depends from Claim 15 and effectively adds the same requirements pertaining to adaptively exposing portions of the surface based on detected movement, as are set forth in Element [1-B].

342. In my opinion, *Shibata* combined with *Kondo* renders the dependent limitations of Claim 19 obvious for the same reasons set forth above with regard to Element [1-B].

13. Claim 20: The memory of claim 15, wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions for different exposure periods based on detected brightness of at least two objects.

343. Claim 20 depends from Claim 15 and effectively adds the same requirements pertaining to adaptively exposing portions of the surface based on detected brightness, as are set forth in Element [3-B].

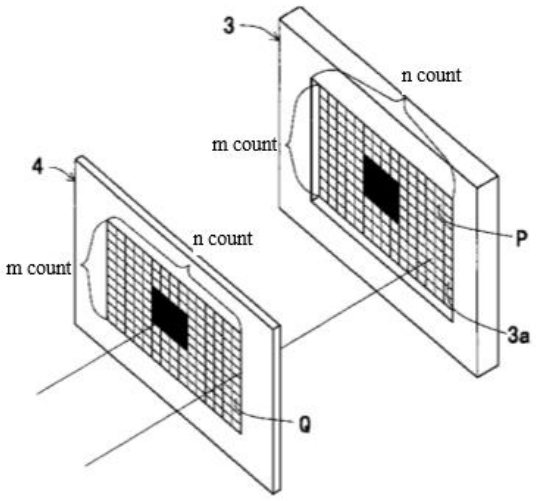
344. In my opinion, *Shibata* teaches the dependent limitations of Claim 20 for the same reasons set forth above with regard to Claim 3.

14. Claim 21: The memory of claim 15, wherein the program controls exposure of the photosensitive pixels according to rows.

345. Claim 21 depends from Claim 15 and additionally adds that "the program controls exposure of photosensitive pixels according to rows."

346. In my opinion, *Shibata* teaches the dependent limitations of Claim 21. As explained above for Claim 2, *Shibata* discloses a CCD exposure surface that is an array of pixels and therefore include rows. *Shibata* explains that the guidance control component 5 that governs when pixels will be exposed during Shibata's method employs a matrix row control component 51 that "controls the opening and closer of the shutters Qm in the m rows of the aforesaid liquid crystal shutter." *Shibata* ¶ [0031], *see also* Figs. 2-3, ¶¶ [0019], [0058].

(FIG. 2)



347. That is, Shibata's program controls exposure of photosensitive pixels according to rows, as claimed.

15. Claim 22: The memory of claim 15, wherein the program controls exposure of the photosensitive pixels individually.

348. Claim 22 depends from Claim 15 and additionally adds that "the program controls exposure of the photosensitive pixels individually."

349. In my opinion, *Shibata* teaches the dependent limitations of Claim 22. *See, e.g.*, Shibata ¶ [0020] ("The aforesaid liquid crystal shutter 4 serves to either guide an optical image from" the photographic lens 1 to each pixel of the aforesaid CCD 3, or obstruct the same and has m x n shutter elements Q arrayed in a matrix of m rows and n column corresponding to the matrix of pixels P of the aforesaid CCD 3, as shown in FIG 2"); *see also* [0041] ("…in S106, the exposure time (Ts) for each pixel P of the CCD 3 corresponding to the period at which each pixel's corresponding shutter element Q in the aforesaid liquid crystal shutter 4 should be maintained in the "guide" state, is calculated"), [0047], [0057], [0058], Fig. 4.

350. It is also my opinion that *Kondo* teaches the dependent limitations of Claim 22. *See Kondo* ¶ [0132] ("It is to be noted that while shutter capable of controlling exposure every respective pixels of CCD 3 is used as shutter 2 in the embodiments of FIGS. 2 to 4, there may be used, *e.g.*, shutter capable of controlling exposure every plural pixels such as two pixels of CCD 3 in addition to the above as shutter 2.").

16. Claim 23: The memory of claim 15, wherein maintaining an image sensing surface at a variable effective image distance synchronously with exposing operates to impose an effective curvature to the sensing surface that approximates a Petzval surface.

351. Claim 23 depends from Claim 15 and additionally adds the same requirements set forth in Claim 9.

352. It is my opinion that *Shibata* teaches the dependent limitations of Claim 23 for the same reasons set forth above with regard to Claim 9.

17. Claim 24: The memory of claim 15, wherein maintaining the image sensing surface at a variable effective image distance from the lens comprises moving the lens relative to the sensing surface.

353. Claim 24 depends from Claim 15 and additionally adds the requirement of "maintaining the image sensing surface at a variable effective image distance from the lens comprises moving the lens relative to the sensing surface."

354. It is my opinion that *Shibata* teaches the dependent limitations of Claim 24 for the same reasons set forth above with regard to Claim 8, where it was discussed how *Shibata* discloses moving the lens.

E. Ground 5 – Shibata, Kondo, and Berge Render Claims 10 and 25 of the '030 Patent Obvious

355. In my opinion, the combination of *Shibata*, *Kondo*, and *Berge* discloses Claims 10 and 25.

356. A POSITA would have found it obvious to combine *Shibata*, *Kondo*, and *Berge* for at least the reasons explained in Section X.E above, above, as well as those discussed in this section.

1. Claim 10

357. In my opinion, the combination of *Shibata*, *Kondo*, and *Berge* discloses Claim 10.

> **[10-PRE] and [10-A]: A method comprising: manipulating an optical relationship between an optical lens and an image sensing surface so that the image sensing surface is spaced at different effective image distances from the lens**

358. Elements [10-PRE] and [10-A] are identical to [1-PRE] and [1-A] and are therefore disclosed by *Shibata* for the same reasons set forth above in Ground 4 with regard to Elements [1-PRE] and [1-A].

> **[10-B]: exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein manipulating the optical relationship comprises altering a shape of the lens.**

359. Claim 10 also requires "exposing different portions of the image sensing surface synchronous with manipulating the optical relationship, wherein manipulating the optical relationship comprises ***altering a shape of the lens***." *Shibata* discloses the limitations of element [1-A].

360. It my opinion, *Shibata* does not disclose manipulating the optical relationship by altering a shape of the lens, *e.g.*, by using a liquid lens that achieves focus by changing shape.

361. But it is also my opinion that *Shibata* does not limit its disclosed technique to requiring any particular type of lens and the main thrust of *Shibata* is

selectively exposing pixels at a range of varying focus points to allow each pixel to be in focus.

362. Because different lens types, including lenses that changed focus by changing their shape, were known in the art, it is my opinion that a POSITA would have readily applied the *Shibata* method to cameras with shape altering lenses to achieve the known benefits of shape altering lenses. And a POSITA would have found it routine to alter a shape of the lens for applications that require automatic and fast focusing. Indeed, as early as 1988, Werner B. Schneider specified an arrangement for demonstration purposes for physics lessons with which the focal length of a lens made of water could be adjusted over a wide focal length range by means of a voltage. And the first liquid lens was developed in 2002 by American scientist Tom Krupenkin. Techniques like these could have readily been implemented alongside *Shibata*.

363. For example, a POSITA would have found it obvious to combine *Shibata* with *Berge,* which teaches a variable focus lens comprised of a mixture of insulating and conductive liquids that can be electrically manipulated into different forms and thereby alter the shape of the lens. *Berge* at FIGS. 1-6, 3:18-39, 4:12-15, 39-43, 5:4-7, 24-27, 61-64.

364. In my opinion, *Berge* explains that this approach provides for a lens with continuously adjustable focus that is both simple to manufacture and use. *Id.* at 1:42-49.

365. It is also my opinion that a POSITA would recognize that the ability to avoid moving parts in focusing would increase the durability and longevity of the focusing mechanism. Indeed, lenses that alter shape, like liquid lenses, allow imaging systems to overcome depth of field limitations by allowing the focus to be electronically adjusted without requiring any mechanical movement. On the other hand, traditional solutions like motorized zoom lenses or physically repositioning the object inevitable creates wear and tear over time. A POSITA would have readily applied lens that alter shape to *Shibata* to utilize these benefits.

2. Claim 25: The memory of claim 15, wherein maintaining the image sensing surface at a variable effective image distance from the lens comprises changing a shape of the lens.

366. Claim 25 depends from Claim 15 and additionally adds the requirements of Element [10-B] concerning altering the shape of the lens.

367. As explained above in connection with Ground 4 regarding Claim 15, *Shibata* discloses the limitations of independent claim 15. Further, *Shibata* combined with *Kondo* and *Berge* renders the dependent limitations of Claim 25 obvious for the same reasons set forth above with regard to Claim 10.

F. Ground 6 – Shibata, Kondo, and Kubo Render Claims 6, 11-14, and 17 of the '030 Patent Obvious

368. In my opinion, the combination of *Shibata*, *Kondo,* and *Kubo* discloses Claims 6, 11-14, and 17.

369. A POSITA would have found it obvious to combine *Shibata*, *Kondo*, and *Kubo* for at least the reasons explained in Section X.F above, above, as well as those discussed in this section.

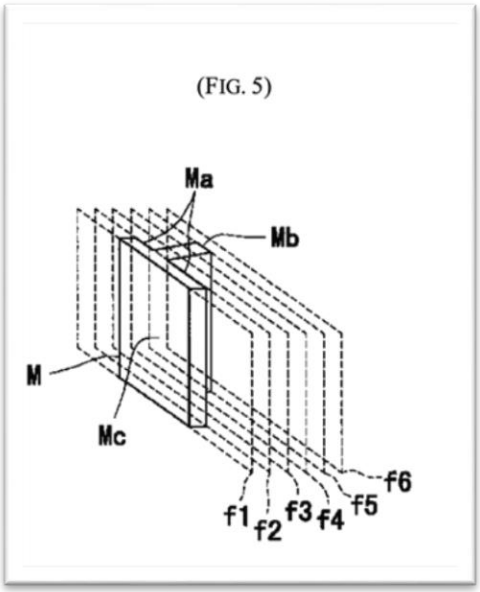
1. Claim 11

370. In my opinion, the combination of *Shibata*, *Kondo,* and *Kubo* discloses Claim 11.

> **[11-PRE], [11-A], and [11-B]: A method comprising: determining a first object distance between a first object in a scene and a lens; determining a second object distance between a second object in the scene and the lens**

371. The first step of Claim 11 requires "determining a first object distance between a first object in a scene and a lens," and the second step requires doing the same for a second object.

372. In my opinion, *Shibata* discloses moving the focus through a range of focus distances f1-f6, as show in in Fig. 5 (below). *See Shibata* ¶¶ [0036-0041]. This is also called contrast detection autofocus.



373. In my opinion, *Shibata* further discloses determining the proper focus position for each of its pixels, which is based on the distance of objects, such as M_A and M_B. As explained above, by the 1990s, cameras routinely supported determining the distance between their lenses and multiple objects. And a POSITA would have understood that *Shibata's* M_A and M_B to be different objects, and the distance between each of them and the is separately determined. A POSITA would have been aware that optimizing *Shibata's* focus by determining the distance to each object in the scene would add to the improvement of the image quality.

374. It is also my opinion that *Kubo* discloses determining the proper focus position based on distance measurements.

375. As I explained above, *Kubo* teaches a method of detecting object movement to determine proper exposure. *Kubo* ¶¶ [0038]–[0040]. *Kubo* further describes a method of measuring the distance between the lens and the subject to determine autofocus control. *Kubo* ¶ [0044], Fig. 6. I also explained above that *Kubo* teaches measuring the brightness of the scene to be photographed. *Kubo* ¶¶ [0036], [0044], [0051], Fig. 6. In other words, *Kubo* teaches measuring distance to the subject independently of the optical system, and subsequently adjust the optical system for correct focus.

376. *Kubo*'s distance-measuring technique has been known in the art for decades. As an example, in 1979, Canon Inc. launched its first autofocus 35mm lens-shutter compact camera: Canon AF35M. The autofocus system in the Canon AF35M used near-infrared light to determine the subject position by triangulation. *See* https://web.archive.org/web/20151223082524/http://www.canon.com/c-museum/en/product/film102.html.

377. Contrast autofocus, as described in *Shibata*, does not measure actual distance. Instead, it analyzes pixels on the camera's sensor, looks at the contrast between edges and moves the focus motor until the contrast is the sharpest.

378. In my opinion, the combination of *Shibata* and *Kubo* would have been a readily apparent one to a POSITA because it was well-known in the art to use distance-measuring autofocus or contrast autofocus, or to combine both to achieve

the best focus. This can be seen in prior art references like U.S. Pub. No. 2003/0081137 to Yamazaki (Ex. 1014), which recognizes that multiple prior art references from the 1990s disclose using both distance-measuring autofocus and contrast focus. Yamazaki ¶¶ [0004]-[0006]. In particular, Yamazaki describes that it was known to use distance-measuring focus first and adopt contrast autofocus system when the measured distance to the subject is small in the 1990s. Yamazaki ¶ [0004]. Yamazaki further teaches an improved autofocus adjustment system, in which distance-measuring autofocus is used to measure distance first and depending on how far the subject is, contrast autofocus is used to search within a narrow area to achieve optimal focus. Yamazaki, ¶¶ Abstract, [0073], Figs. 7-8.

379. U.S. Pub. No. 2003/0007076 to Okisu (Ex. 1013) provides a prior art example of how it was well known that camera systems could measure distance to objects to determine focus in multiple ways, and that this determination was simply a design choice. For example, Okisu describes two common ways of determining focus in a camera system and recognizes (as a POSITA would) that either of these options can be employed interchangeably. One is contrast detection autofocus, which evaluates the quality of the image at the sensor as focus is changing to determine when an object is in focus. *Okisu* ¶ [0093]. The other is the use of separate range finding sensor to directly measure the distance to the objects of interest. *Id.*

380. While *Shibata* does not expressly disclose the use of distance measuring sensors to determine focus, *Kubo* teaches the use of distance measuring to determine autofocus control. *Kubo* ¶ [0044], Fig. 6. In other words, *Kubo* teaches measuring distance to the subject independently of the optical system, and subsequently adjusting the optical system for correct focus.

381. It is thus my opinion that a POSITA would have understood that either distance-measuring focus as described in *Shibata*, or contrast autofocus as described in *Kubo* can be used for focusing. Based on the well-known need to achieve optimal focus, it is also my opinion that a POSTA would also have been motivated to combine the distance-measuring autofocus in *Shibata* and contrast autofocus in *Kubo* to achieve to achieve higher speed and accuracy, depending on whether there is movement in the subject.

[11-C] and [11-D]: within a continuous exposure frame: exposing a first portion of an image sensing surface while the image sensing surface is at a first effective image distance from the lens, where the first effective image distance corresponds to the first object distance, exposing a second portion of the image sensing surface while the image sensing surface is at a second effective image distance from the lens, where the second effective image distance corresponds to the second object distance; and combining the exposed first and second portions into a single image

382. The third and fourth steps of Claim 11 require "within a continuous exposure frame: exposing a first portion of an image sensing surface while the image sensing surface is at a first effective image distance from the lens, where the

first effective image distance corresponds to the first object distance" and, within the same continuous exposure frame "exposing a second portion of the image sensing surface while the image sensing surface is at a second effective image distance from the lens, where the second effective image distance corresponds to the second object distance; and combining the exposed first and second portions into a single image."

383. In my opinion, *Shibata* discloses these limitations.

384. This is my opinion both under a plain meaning claim construction, and also under the proposed construction of "within a continuous exposure frame" as "within the period from the start of an exposure of the imaging sensing surface until the entire image sensing surface is exposed once" that I discussed above in Section VIII.A.

385. In my opinion, *Shibata* teaches that the lens is moved to various focus points within a single exposure, and pixels are exposed by shutter elements Q only when the lens is positioned at the focus point that would cause the exposed pixels to be in focus. *Shibata* ¶¶ [0044]-[0051], Fig. 6.

386. It is also my opinion that *Shibata* teaches that the exposed pixels (including the first and second portions) are combined into a single image, as Shibata teaches that after the main photography phase, "the accumulated charge of all pixels of the aforesaid CCD is read out," resulting in a single image that

combines each of the portions that were separately exposed during main photography. *Id.* ¶ [0053].

2. Claim 12: The method of claim 11, wherein the single image is displayed on a digital graphical user interface

387. Claim 12 depends from Claim 11 and additionally requires that the single image be displayed on a digital GUI.

388. In my opinion, *Shibata* and *Kubo* combined with *Kondo* renders the dependent limitations of claim 12 obvious. *Shibata* discloses a digital camera but does not explicitly disclose a display that displays the captured images. *Shibata* ¶ [0001].

389. By June 2005, digital cameras were ubiquitous. In my opinion, it was well known that the display on a digital camera would be used to display the final captured images. And a POSITA would have been motivated to use a digital camera display, like the one on my first digital camera in the 1990s, so that the camera's user could instantly see the images they captured and confirm that they liked the way the look, which is of course a highly demanded feature.

390. In my opinion, *Kondo* expressly discloses that a display unit 102 can display images as they are taken. *Kondo* ¶ [0042].

391. In my opinion, because the ability to instantly preview final output images was a key and heavily desired feature of digital cameras, a POSITA would expect *Shibata*'s camera to include a display that could display its final output

captured images, such as the combined image discussed above for Claim 11, or at least find it obvious to modify *Shibata* in light of *Kondo*'s disclosure to include that feature. A POSITA would have expected a display in a digital camera to display what would be included in a photograph to improve and optimize the user experience and give the user the opportunity to confirm the image quality.

3. Claim 13: The method of claim 11, wherein exposing the first and second portion of the image sensing Surface comprises adaptively exposing said portions for a first and second exposure time based on a detected brightness of the first and second objects.

392. Claim 13 depends from Claim 11 and additionally requires that "exposing the first and second portion of the image sensing surface comprises adaptively exposing said portions for a first and second exposure time based on a detected brightness of the first and second objects." In other words, Claim 13 effectively adds the same requirements set forth in Element [3-B].

393. In my opinion, *Shibata* teaches the dependent limitations of claim 13 for the same reasons set forth above with regard to Claim 3 in Ground 4.

4. Claim 14: The method of claim 11, wherein exposing the first and second portion of the image sensing Surface comprises adaptively exposing said portions for a first and second exposure time based on a detected speed of movement of the first and second objects.

394. Claim 14 depends from Claim 11 and additionally requires that "wherein exposing the first and second portion of the image sensing surface

comprises adaptively exposing said portions for a first and second exposure time based on a detected speed of movement of the first and second objects." In other words, Claim 14 effectively adds the same requirements set forth in Element [1-B].

395. *Shibata* and *Kubo* combined with *Kondo* renders the dependent limitations of claim 13 obvious for the same reasons set forth above with regard to Claim [1-B] in Ground 4.

5. Claim 6: The method of claim 4, wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions based on at least a detected first and second object distance.

396. Claim 6 depends from Claim 4 and additionally requires "wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions based on at least a detected first and second object distance." In other words, Claim 6 adds a subset of the elements of Claim 11.

397. As explained above in connection with Ground 4 regarding Claim 4, *Shibata* discloses the limitations of independent Claim 4. Further, *Shibata* combined with *Kondo* and *Kubo* renders the dependent limitations of Claim 6 obvious for the same reasons set forth above with regard to Claim 11.

6. Claim 17: The memory of claim 15, wherein exposing different portions of the image sensing surface comprises adaptively exposing said portions based on at least a detected first and second object distance.

398. Claim 17 depends from Claim 15 and again adds the same subset of the elements of Claim 11 as Claim 6.

399. As explained above in connection with Ground 4 regarding Claim 15, *Shibata* discloses the limitations of independent Claim 15. Further, *Shibata* combined with *Kondo* and *Kubo* renders the dependent limitations of Claim 17 obvious for the same reasons set forth above with regard to Claim 11.

XII. SECONDARY CONSIDERATIONS

400. I am not aware of secondary considerations of non-obviousness that bear on the challenged claims. If I am made aware in the future of arguments of any secondary consideration, I expressly reserve the right to assess those arguments when they arise in order to form opinions regarding their correctness.

XIII. SUMMARY

401. It is my opinion that claims 1-25 of the ’030 Patent were obvious to a POSITA given the prior art references discussed above.

I declare under penalty of perjury that the foregoing is true and correct. Executed this 7th day of September, 2022 in Brussels belgium.

Dr. Michael Lebby