

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TESLA INC.,
Petitioner,

v.

INTELLECTUAL VENTURES II LLC,
Patent Owner.

IPR2025-00222
U.S. Patent No. 9,232,158

**DECLARATION OF R. MICHAEL GUIDASH,
UNDER 37 C.F.R. § 1.68 IN SUPPORT OF PETITION FOR
INTER PARTES REVIEW**

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I, R. Michael Guidash, do hereby declare as follows:

I. INTRODUCTION

1. I am making this declaration at the request of Tesla Inc. in the matter of the *Inter Partes* Review of U.S. Patent No. 9,232,158 (“the ’158 patent”) to Olsen *et al.*

2. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this investigation. My compensation is not contingent on the outcome of this matter or the specifics of my testimony, and I have no other interest in this case or the parties thereto.

3. I have been asked to provide my opinions regarding whether Claims 1-2, 4-5, 8-11, 13-16, and 19 (“Challenged Claims”) of the ’158 patent are unpatentable as they would have been obvious to a person having ordinary skill in the art (“POSITA”) at the time of the alleged invention, in light of the prior art. It is my opinion that all of the limitations of the challenged claims would have been obvious to a POSITA.

4. In forming the opinions set forth in this declaration, I have reviewed the documents in the following table:

Ex.1001	U.S. Pat. No. 9,232,158 to Olsen et al. (“the ’158 patent”)
Ex.1002	Prosecution History of U.S. Application No. 14/063,236 (issued as the ’158 patent)

Ex.1005	U.S. Pat. No. 6,611,289 to Yu et. al (“Yu”)
Ex.1006	U.S. Pat. No. 7,365,780 to Miyazaki (“Miyazaki”)
Ex.1007	JP Application Publication No. JP2003-319231 to Matsushima (Certified English Translation + Declaration + Japanese) (“Matsushima”)
Ex.1008	Eastman Kodak Company, Shutter Operations for CCD and CMOS Image Sensors, Application Note, MTD/PS-0259, Revision 1 (October 23, 2001) (retrieved from https://web.archive.org/web/20030419002619/http://www.kodak.com/global/plugins/acrobat/en/digital/ccd/applicationNotes/ShutterOperations.pdf)
Ex.1009	Eastman Kodak Company, Kodak CMOS Image Sensors White Paper (November 10, 2000) (retrieved from https://web.archive.org/web/20010611235410/http://www.kodak.com/US/plugins/acrobat/en/digital/ccd/cmos.pdf)
Ex.1010	Eastman Kodak Company, Kodak Digital Science KAC-0311 Image Sensor (August 5, 2002) (retrieved from https://web.archive.org/web/20030411152500/http://www.kodak.com/global/plugins/acrobat/en/digital/ccd/products/cmos/KAC-0311LongSpec.pdf)
Ex.1011	U.S. Pat. No. 7,733,414 to Kobayashi
Ex.1012	Dave Litwiller, “CCD vs. CMOS: Facts and Fiction, Photonics Spectra,” (January 2001)
Ex.1013	U.S. Application Pub. No. 2004/0239771 to Habe
Ex.1014	EP Application Pub. No. EP0858208 to Weldy et al.
Ex.1015	Memorandum in Support of Claim Construction Order, <i>Intellectual Ventures I LLC et al. v. General Motors Company et al.</i> , 6:21-CV-1088 (WDTX), December 1 st , 2022
Ex.1016	Texas Instruments, TC255P 336- × 244-PIXEL CCD IMAGE SENSOR (March 2003)

Ex.1021	Eastman Kodak Company, Solid State Image Sensors Terminology, Application Note, DS 00-001, Revision 0 (December 8, 1994) (retrieved from https://web.archive.org/web/20030413064955/http://www.kodak.com/global/plugins/acrobat/en/digital/ccd/applicationNotes/terminology.pdf)
Ex.1022	U.S. Pat. No. 7,830,435 to Guidash
Ex.1023	Eastman Kodak Company, Charge Coupled Device (CCD) Image Sensors, CCD Primer, MTD/PS-0218, Revision No. 1 (May 29, 2001) (retrieved from https://web.archive.org/web/20030422183725/http://www.kodak.com/global/plugins/acrobat/en/digital/ccd/applicationNotes/chargeCoupledDevice.pdf)
Ex.1024	Szeliski, "Image Mosaicing for Tele-Reality Applications," (May 1994)
Ex.1025	Mann et al., "On Being 'Undigital' with Digital Cameras: Extending Dynamic Range By Combining Differently Exposed Pictures," (May 1995)
Ex.1026	Debevec et al., "Recovering High Dynamic Range Radiance Maps from Photographs," SIGGRAPH '97: Proceedings of the 24th annual conference on Computer graphics and interactive techniques, 369-378 (August 1997)
Ex.1027	PCT Pub. No. WO2001/010110 to Stark
Ex.1028	Yang et al., "A 640 512 CMOS Image Sensor with Ultrawide Dynamic Range Floating-Point Pixel-Level ADC," IEEE Journal of Solid-State Circuits, VOL. 34, NO. 12 (December 1999)
Ex.1029	CCD Electronic Shutters, Interactive Java Tutorial, October 22, 2002 (retrieved from https://web.archive.org/web/20021028042044/https://micro.magnet.fsu.edu/primer/java/digitalimaging/ccd/shutter/index.html)
Ex.1030	Prosecution History of U.S. Application No. 11/212,803 (abandoned)
Ex.1031	Prosecution History of U.S. Application No. 11/788,122 (issued as

	U.S. Pat. No. 7,564,019)
Ex.1032	Prosecution History of U.S. Application No. 12/496,854 (issued as U.S. Pat. No. 8,198,574)
Ex.1033	Prosecution History of U.S. Application No. 13/465,229 (issued as U.S. Pat. No. 8,334,494)
Ex.1034	Prosecution History of U.S. Application No. 13/681,603 (issued as U.S. Pat. No. 8,598,504)
Ex.1035	Holst, CCD arrays, Cameras, and Displays, 2nd edition (1998)
Ex.1036	U.S. Pat. No. 4,831,403 to Ishida et al.
Ex.1037	U.S. Pat. No. 7443,427 to Takayanagi
Ex.1038	U.S. Pat. No. 4,642,679 to Nagano
Ex.1039	e2v Technologies, CCD Sensors Technical Note: Glossary of Terms (2003)
Ex.1040	Ralph E. Jacobson et al., The Manual of Photography: photographic and digital imaging, 9th Edition (2000)
Ex.1041	U.S. Pat. No. 6,215,597 to Duncan et al.
Ex.1042	O'Donnell, The Practical Use of the Exposure Triangle (retrieved from https://creativeraw.com/practical-use-exposure-triangle-explained/)
Ex.1043	U.S. Pat. No. 2,953,983 to Larson

5. Additionally, I have utilized my own experience and expertise, including regarding the knowledge and capabilities of a person of ordinary skill in the relevant art in the timeframe of the claimed priority date of the '158 patent.

6. Unless otherwise noted, all emphasis in any quoted material has been added.

II. QUALIFICATIONS AND PROFESSIONAL EXPERIENCE

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

8. After graduating with a Bachelor of Science in Electrical Engineering from the University of Delaware in 1981, I started my career with Eastman Kodak as a product engineer for application specific integrated circuits (ASIC's) used to perform photometer functions, (e.g. auto-exposure, auto-focus and flash control), for Kodak film cameras. In this role, I was responsible for all aspects of IC test, packaging, delivery, customer interface and failure analysis, yield and cost of the photometer ASICs. This required detailed knowledge of camera designs, functions and operation. This role continued until 1987 and included responsibility for copier output driver ASICs and photometer ASICs for Kodak DISC cameras and Instant Film cameras.

9. In 1986-1988, I began transitioning to the Kodak Research Laboratories and CCD wafer fabrication facility. During my time with the Kodak Research Laboratories and CCD wafer fabrication facility, I developed 2 μm and 1 μm CMOS processes, and a 30 V 4 μm Bipolar complementary metal-oxide-semiconductor (BiCMOS) process. These processes were used for gate arrays for

many Kodak products and output driver ASICs for all of Kodak's copiers. During this time, I was also awarded entrance into the Special Opportunity Graduate Program that allowed me to obtain a Master's of Science in Electrical Engineering from the Rochester Institute of Technology. My Master's Thesis involved design and process integration of bipolar and CMOS transistors into an existing CCD (charge-coupled device) image sensor process.

10. In 1989, I initiated and began leading a Smart Sensor Group which developed BiCMOS-CCD processes to provide fully integrated CCD systems on a chip. I also served as product engineer and yield enhancement engineer for Kodak's high volume CCDs. During this time, I led product delivery and technology development of all ASIC and smart sensor products used in Kodak copiers and other electronic products, and CCD sensor yield improvement for sensors used in Nikon digital SLR cameras. I developed a number of products during this time to include an interline CCD integrated with 2 μm CMOS on the same chip, and linear CCD image sensor with on-chip timing and control. I also led and directed the CCD dark current and point defect reduction team.

11. In 1996, I formally started the CMOS Image Sensor group at Kodak. From 1996 to 2009, I managed the R&D and product development of CMOS Image Sensor (CIS) programs. As is further shown in my curriculum vitae, I was the inventor or co-inventor of many key patents in the field of CMOS image

sensors including pinned photodiode pixels, camera-on-a-chip architecture, and shared amplifier pixel architectures. During this time, I led the development of the world's 1st pinned photodiode CIS product, Shared amplifier CIS pixel product, and the world's first ½ inch optical format 1.3 megapixel CMOS image sensor into mass production, providing successful delivery to several compact digital camera products for Kodak and other camera manufacturers. I also led the development of one of the earliest 3D hybrid stacked backside illuminated (BSI) CIS architecture. This led to demonstration of very high performance, low dark current BSI prototype sensors with pixel sizes ranging from 0.9µm to 5.0µm. During development of these CIS devices, I worked closely with Kodak's and external companies' digital camera developers, and these CIS devices were commercialized in Kodak consumer digital cameras, as well as other companies' low-cost compact digital cameras.

12. In 2001, product development was transferred to other individuals and my role was focused on CIS and R&D. During this time, I initiated and led a cross-functional camera R&D team directed at CIS and other Kodak technologies for novel co-optimized cameras and camera sub-systems, including cell phone camera modules with small form factors, improved low light response, and fast auto-focus. During this time, I interfaced with cell phone camera manufacturers regarding their requirements and presented our technological improvements and camera module

and CIS roadmaps.

13. In 2009, when Kodak closed its CMOS Image Sensor Business, I transitioned into a role as an intellectual property technologist and coordinator. This role included managing remaining image sensor patent applications and office actions, managing broad electronic components patent applications and office actions, and providing technical support for intellectual property sales and licensing teams.

14. In 2012 I left Kodak and started my consulting company, providing technical consulting services for CMOS image sensors. In this role I provide consulting services for processes, pixels, circuits, sensor architectures, systems and intellectual property to companies and clients.

15. I am a named inventor on over 100 issued US patents. The majority of these patents are directed toward technologies relevant to cameras and image sensors.

III. LEVEL OF ORDINARY SKILL IN THE ART

16. I understand there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including (1) the levels of education and experience of persons working in the field at the time of the invention; (2) the sophistication of the technology; (3) the types of problems encountered in the field; and (4) the prior art solutions to those problems.

17. It is my understanding that the earliest possible priority date for the '158 patent is August 25, 2004. A person of ordinary skill in the art ("POSITA") in the field of the '158 patent, as of August 25, 2004, would have been someone knowledgeable and familiar with the digital imaging systems arts that are pertinent to the '158 patent. That person would have a bachelor's degree from an accredited program in electrical engineering, computer engineering, computer science, or a related field and 2-3 years of experience in digital imaging systems. Lack of work experience can be remedied by additional education, and vice versa.

18. For purposes of this Declaration, in general, and unless otherwise noted, my statements and opinions, such as those regarding my experience and the understanding of a POSITA generally (and specifically related to the references I consulted herein), reflect the knowledge that existed in the field as of the earliest priority date of the '158 patent (i.e., August 25, 2004). Unless otherwise stated, when I provide my understanding and analysis below, it is consistent with the level of a POSITA as of the alleged priority date of the '158 patent.

IV. RELEVANT LEGAL STANDARDS

19. I am not an attorney. In preparing and expressing my opinions and considering the subject matter of the '158 patent, I am relying on certain basic legal principles that counsel have explained to me. These principles are discussed below.

20. I understand that prior art to the '158 patent includes patents and printed publications in the relevant art that predate the priority date of the alleged invention recited in the '158 patent.

21. I have been informed that a claimed invention is unpatentable under 35 U.S.C. § 103 if the differences between the invention 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 art to which the subject matter pertains. I have also been informed by counsel that the obviousness analysis takes into account factual inquiries including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed subject matter.

22. I have been informed by counsel that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include the following: (a) combining prior art elements according to known methods to yield predictable results; (b) simple substitution of one known element for another to obtain predictable results; (c) use of a known technique to improve a similar device (method, or product) in the same way; (d) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions, with a

reasonable expectation of success; and (f) some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

V. TECHNICAL BACKGROUND

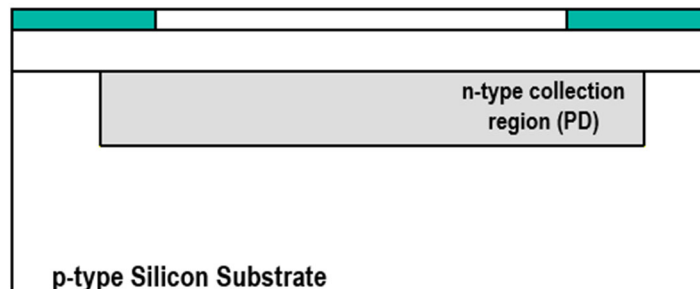
23. In its background, the '158 patent discusses various well-known components and techniques in digital imaging, including image sensors, controlling exposure times for image sensors, and expanding dynamic range for image sensors. Ex.1001, 1:32-2:42. All these techniques were not only well-known, but also widely available in commercial products, such as those offered by Eastman Kodak Company ("Kodak"). *See e.g.*, Ex.1009 (Kodak Image Sensors White Paper describing Kodak's leading technology in image sensors); Ex.1008 (Kodak Shutter Operations Application Note describing shutters in digital cameras to control photodiode integration times).

A. Image Sensors

24. Image sensors are devices "capable of converting an incident optical pattern (i.e. image) into an electronic signal which contains all spatial and intensity relationships of the original pattern," and the term is "usually used to refer to solid state semiconductor image sensors." Ex.1021, 24. There were two well-known types of image sensors: "CCD (Charge Coupled Device)

image sensors,” and “CMOS (Complementary Metal Oxide Semiconductor) image sensors.” Ex.1009, 2.

25. Both CCD image sensors and CMOS image sensors (also referred to as CIS) include an array of photosensitive cells, also referred to as pixels, on the image sensor chip, that respond to light that is striking the chip. Each pixel includes a photodetector, usually a photodiode (PD) including a p-n junction. I have created a simplified cross-sectional diagram of a photodiode for illustration below.



26. While the CCD and CMOS image sensor pixels structures are different, the basic imaging process using the pixels is the same, which includes: (1) converting incident light into an electrical charge, (2) collecting and spatially confining the charge in the pixel, and (3) transferring the collected charge from the photodetector to be converted into a voltage and readout. Ex.1023, 5.

27. First, the photodiode converts light (photons) into charge (electrons), which are integrated at pixel sites of image sensors. Ex.1009, 4

(“The photodiode converts light (photons) into charge (electrons).” FIG. 7 of Ex.1023 below illustrates the photon interaction with silicon “converting light (photons) to electronic charge.” Ex.1023, FIG. 7, 5 (“An image is acquired when incident light, in the form of photons, falls on the array of pixels. The energy associated with each photon is absorbed by the silicon and causes a reaction to take place. This reaction yields the creation of an electron-hole charge pair (or simply an electron)”). “The number of electrons collected at each pixel is linearly dependent on light level and exposure time and non-linearly dependent on wavelength.” Ex.1023, 5.

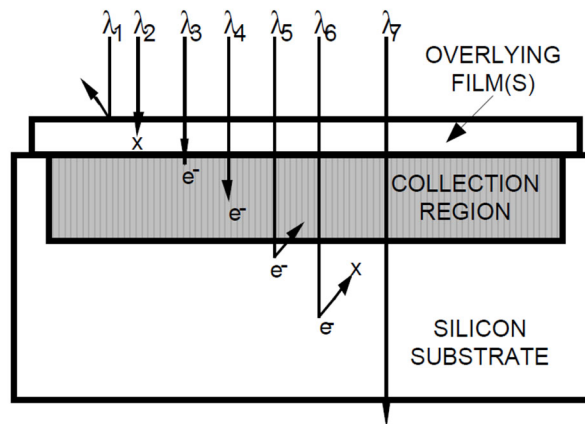


Figure 7 - Photon Interaction with Silicon

Ex.1023, FIG. 7.

28. Second, the photoelectrons are collected (integrated) and spatially confined within each photodiode. Fig. 8 of Ex.1023 below illustrates an example photodiode structure, which “consists of a vertically stacked

conductive material (doped polysilicon) overlying a semiconductor (silicon) separated by a highly insulating material (silicon dioxide).” Ex.1023, 6.

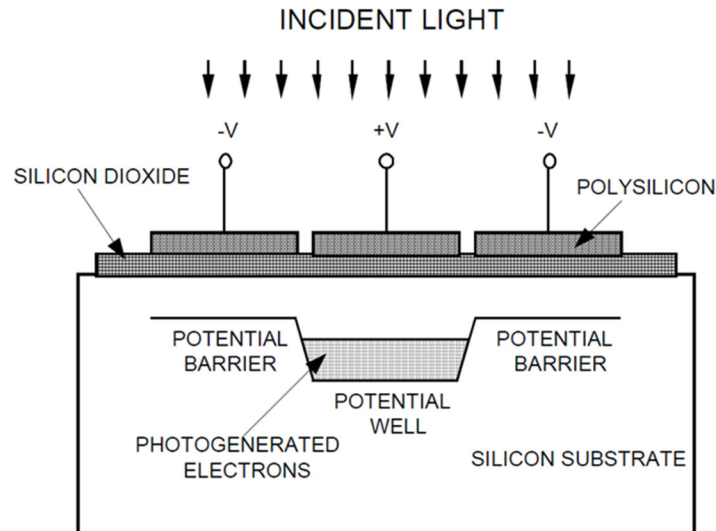


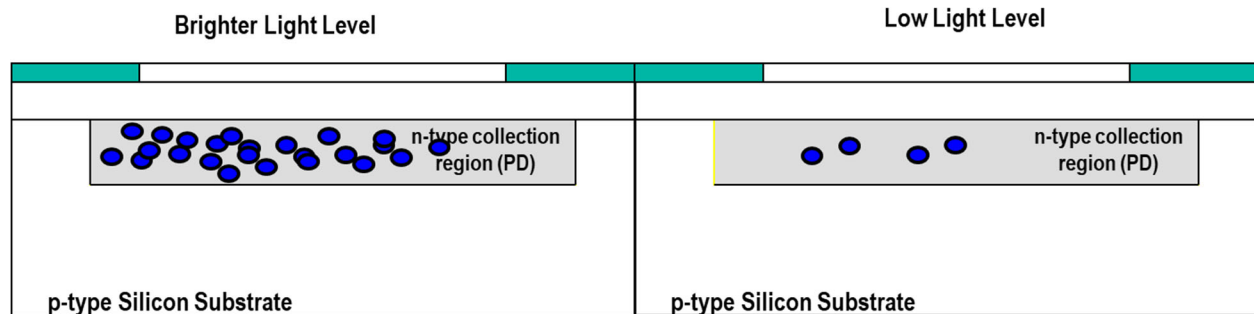
Figure 8 - Potential Well and Barriers

Ex.1023, FIG. 8.

29. As shown in FIG. 8 of Ex.1023 above, by applying a voltage potential to the polysilicon or “gate” electrode, a potential “well” can be formed “which has the capability of collecting the localized electrons that were created by the incident light.” Ex.1023, 6.

30. The electrical charge (number of electrons) collected in each PD is proportional to (1) amount of light incident on that PD; and (2) the time that the resulting photoelectrons are collected, which is also called “integration time.” The resulting amount of charge in the photodiode is a measure of brightness for a particular part of the scene that the incident light has arrived from. I have created a

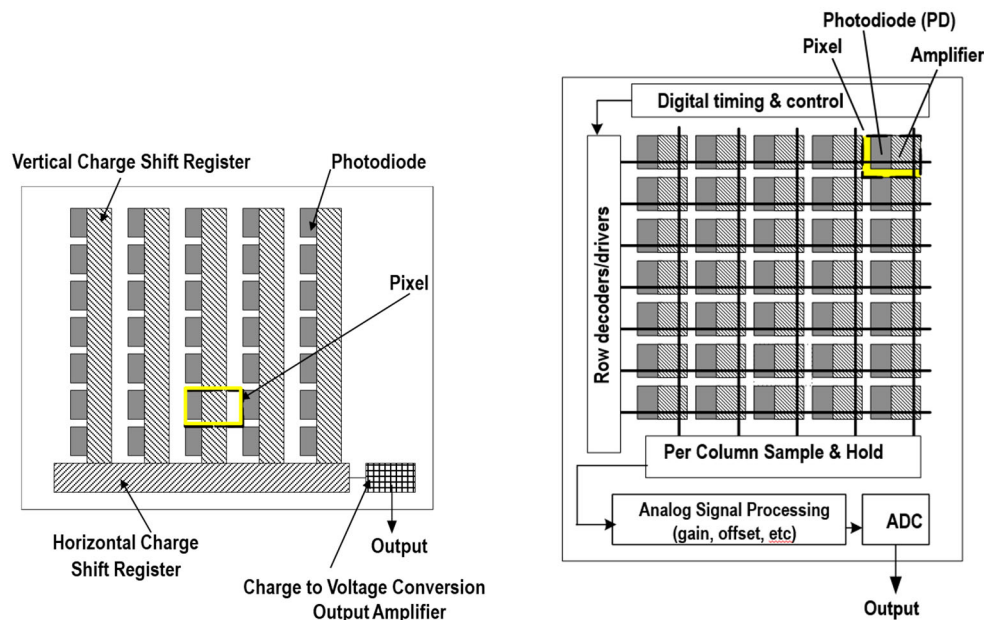
simplified diagram below showing the collected charge in two adjacent pixels, one with a lower light level and one with a brighter light level. The collection and spatial confinement of charge (photoelectrons shown as blue dots) is a critical process of the image capture process.



31. Third, after “charge has been integrated and held locally by the bounds of the pixel architecture,” charge transfer techniques are applied to “move the packets of charge within the silicon substrate.” Ex.1023, 5-6. Readout techniques are then performed, “where the electrons (which represent a charge) are converted to a voltage.” Ex.1023, 10.

32. Specifically, some transistors associated with the pixel transfer the charge out of the PD and convert the collected charge to an electrical signal, typically a voltage. These electrical signals are used to produce a digital image. CCD and CIS devices are shown in the figures that I created below, CCD on the left, CIS on the right. There is a noise associated with reading out of the pixel and converting it to a voltage. This noise is determined by measuring the temporal and spatial variation of the image output signals when the image sensor is not exposed

to light, i.e. in the dark. This “read noise” will limit the signal to noise ratio (SNR) in the dark regions of a scene or a low light imaging situation. Low light image quality is dependent on the SNR of the readout. For example, if the read noise is 4 electrons, in order to get a SNR of 10, the pixel will need to collect 40 electrons. In very low light this will require a longer integration time to get a desired SNR.



33. The amount of charge (number of electrons) that the PD can hold is limited. This maximum level, called Full Well Capacity (FWC), is determined by photodetector size, and photodetector electrical capacitance. If a region in a scene is very bright, the resulting number of photoelectrons can exceed the FWC (become saturated), and the image information in that part of scene is lost (clipped to the FWC level).

34. As a result of this FWC limitation, one cannot simply increase the

integration time of the sensor in order to collect more charge in the dark regions of the scene in an attempt to increase the SNR of the dark regions, because this would cause the photodetectors capturing the bright regions of the scene to saturate. The dynamic range of the image sensor, discussed below, is related to this trade off with dark regions and bright regions.

B. Dynamic Range

1. True Dynamic Range vs. Intra-Scene Dynamic Range

35. Two well-known types of dynamic range—true dynamic range and intra-scene dynamic range—are described in the '158 patent.

36. Specifically, the '158 patent states, “[d]ynamic range is measured as the ratio of the maximum photo-charge that can be meaningfully integrated in a pixel of the imager to the pixel noise level.” Ex.1001, 1:40-42. Each pixel has a “maximum photo-charge,” because the “finite charge storage capacitance within each pixel limits the amount of integrated photo-charge.” Ex.1001, 1:38-39. This type of dynamic range is referred to as “true dynamic range” or “DR” in the art. Ex.1009, 9 (“True dynamic range is a measure of the sensor’s maximum number of signal electrons compared to its total dark temporal RMS noise level.”).

37. Another type of dynamic range is referred to in the art as “intra-scene dynamic range” or “IDR,” which refers to the range of illumination levels within

a single scene. Ex.1009, 9 (“Intra-scene dynamic range (IDR) refers to the range of illumination levels within a single scene”). *See also* Ex.1001, 1:43-45 (“[i]ntrascene dynamic range refers to the range of incident light that can be accommodated by an image sensor in a single frame of pixel data,” providing examples with a high intra-scene dynamic range including “an indoor room with a window view of the outdoors, an outdoor scene with mixed shadows and bright sunshine, and evening or night scenes combining artificial lighting and shadows.”).

2. Expanding Intra-Scene Dynamic Range Using Multiple Integration Times

38. Techniques for capturing pictures with different integration times and combining the pictures to achieve expanded intra-scene dynamic range were well-known. *See, e.g.,* Ex.1009, 9; Ex.1024, 3 (Abstract discussing the “fundamental technique” of “image mosaicing, i.e., the automatic alignment of multiple images into larger aggregates); Ex.1025, 7, FIG. 8 (illustrating combining images of different exposures including “underexposed,” “properly exposed,” and “overexposed”); Ex.1026, 1 (providing high dynamic range by fusing multiple photographs with different amounts of exposure into a single high dynamic range radiance map); Ex.1014, FIGS.1a-1c, 3, 5:14-20 (describing producing a combined digital image having improved characteristics using two electronic images, where “scene exposure conditions” are selected “in a way that provides for improving various characteristics,” where “all the greater than two lens/sensor systems are

used to simultaneously capture light information from the same scene”); *see also* Ex.1001, 1:57-58 (citing U.S. Pat. Nos. 4,647,975, 5,168,532, and 5,671,013, the ’158 patent acknowledging that it was known that “[intra-scene] dynamic range of an image sensor can be increased by using multiple exposure times and/or integration times.”).¹

39. Specifically, Kodak Image Sensor White Paper explains in detail the technique for expanding intra-scene dynamic range. Ex.1009, 9. As an example, a sensor can take two pictures with “a long integration time” and “a short integration time” respectively. Ex.1009, 9. “The picture with the long integration time will provide good details in the dark regions of the scene but the bright regions may not show good details since too many electrons may have overpowered, or saturated the pixel.” Ex.1009, 9. On the other hand, “the picture with the short integration time will provide good details in the bright

¹ The ’158 patent also uses the terms “dynamic exposure range” and “effective single-frame dynamic exposure range.” *See e.g.*, Ex.1001, 1:26-87 (“expanding the dynamic exposure range”), 2:40-42 (“the effective single-frame dynamic exposure range is expanded”). A POSITA would have understood that these terms refer to the intra-scene dynamic range, directed at an expanded dynamic range of a scene. Ex.1009, 9.

areas (because the pixels did not saturate), but now, there are not enough photons captured to provide good details in the darker regions of the scene.” *Id.*

40. As such, an image with a high intra-scene dynamic range can be achieved by combining two images captured with different integration times, where “signal processing electronics can be used to blend these two images to provide both the dark and bright regions of the scene.” *Id.* In other words, a high IDR is achieved to capture details of both the bright and dark areas, without the requirement of a high true dynamic range, since the details of the darker parts of the scene are captured by the image that has a short integration time, and the details of the brighter part of the scene is captured with the other image that has a longer integration time.

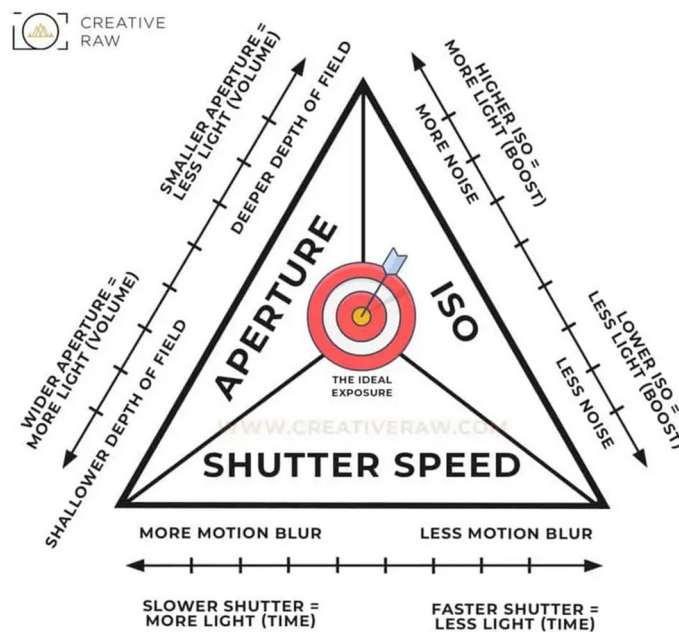
C. Exposure

41. Exposure “is important for any photographic situation in terms of the resulting quality of the photographic image.” Ex.1040, 310 (describing that generally, “the photographic result of exposure (H) is the product of image illuminance (E) and exposure duration (t), so that $H = Et$.”).

42. “The four principal variables determining camera exposure are subject luminance, film speed, lens aperture and shutter speed.” Ex.1040, FIG. 19.1, 310. As shown in the figure below, in film cameras, to capture a scene having a given subject luminance, three parameters are available to control

exposure: (1) film speed, which is measured on a scale published by the International Organization for Standardization (ISO), that measures the sensitivity of the film to the light; (2) lens aperture that controls how much light is incident on the film; and (3) shutter speed, also referred to exposure time, that controls the length of time that the film is sensing and responding to incident light.

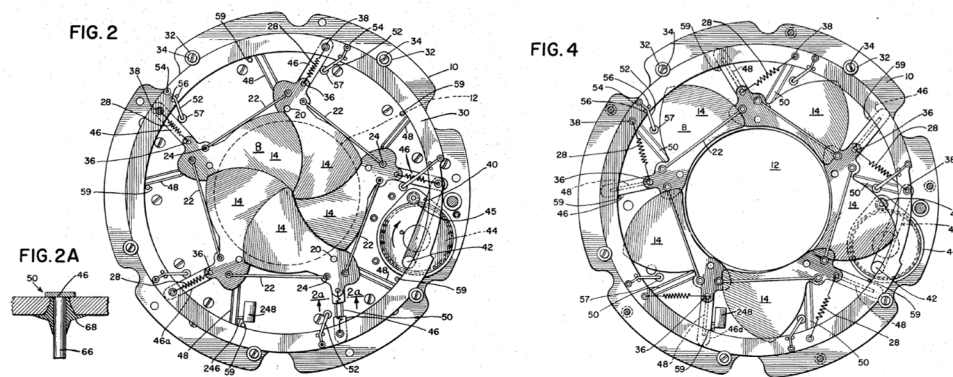
Ex.1040, FIG. 19.1, 310.



Ex.1042, 1.

43. In film cameras, exposure control generally can be done with one or a combination of these three parameters. The choice of which ones to use or prioritize is based on the attendant primary consideration of each. For example, shutter speed impacts motion blur, lens aperture impacts depth of field, and ISO speed impacts image noise.

44. Shutter speed for film cameras is controlled using a traditional mechanical shutter, which is a physical mechanism that opens and closes to allow light to reach the film. A mechanical shutter is located in front of the film, so that it can physically block incident light from reaching the film. The specific types of mechanical shutters have evolved over time. Older cameras used a leaf shutter located inside the photographic lens, where the exposure time is the duration of the entire time period from fully closed to full open and then to fully closed again. An example leaf shutter is illustrated below, where the left figure illustrates the leaf shutter in closed position, and the right figure illustrate the left shutter in open position.



Ex.1043, FIGS. 2 and 4.

45. Another type of mechanical shutter is called a “focal plane shutter,” which is positioned immediately in front of the focal plane of the camera, that is, right in front of the photographic film. A focal plane shutter usually includes shutter blades (also referred to as shutter curtains) that move

horizontally or vertically to open and close.

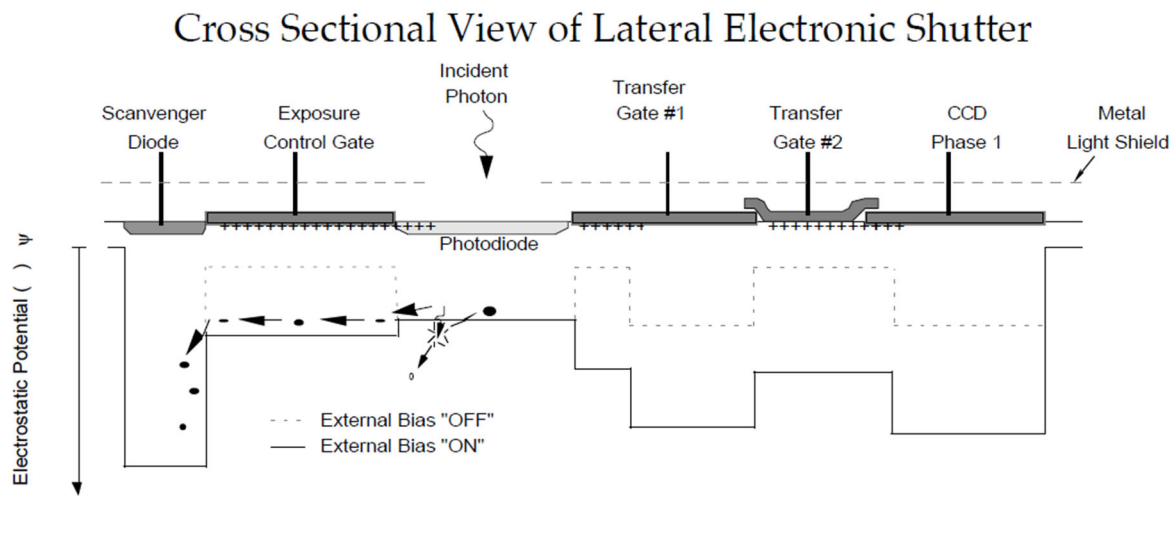
46. Exposure control in digital cameras is very similar to that used in film cameras. Since digital cameras use semiconductor image sensors in place of film, there are some differences for ISO and shutter speed.

47. ISO in digital cameras is controlled by electrical voltage gain (amplification), and increasing the voltage gain in the image sensor signal readout circuits may produce a larger voltage signal for the same amount of charge collected in the photodiode, such that the signal voltage is more sensitive to light. Ex.1013, [0022]. Further, increasing the voltage gain in the first stage of the signal readout circuits may reduce the readout noise which improves the SNR of low light images.

48. Shutter speed/exposure time in digital cameras is also referred to as integration time, which can be controlled “either by incorporating an external mechanical shutter in front of the image sensor or by incorporating an on-chip electronic shutter.” Ex.1008, 2; Ex.1013, [0024] (“It is to be noted that in a camera having a mechanical shutter used to control the length of time over which the light flux enters the image-capturing element 6, the length of time over which the shutter remains open is equivalent to the shutter speed. In a camera having an electronic shutter used to control the length of time over which charges are stored at the image-capturing element 6, the length of time

over which the electrical charges are stored at the image-capturing element 6 is equivalent to the shutter speed.”).

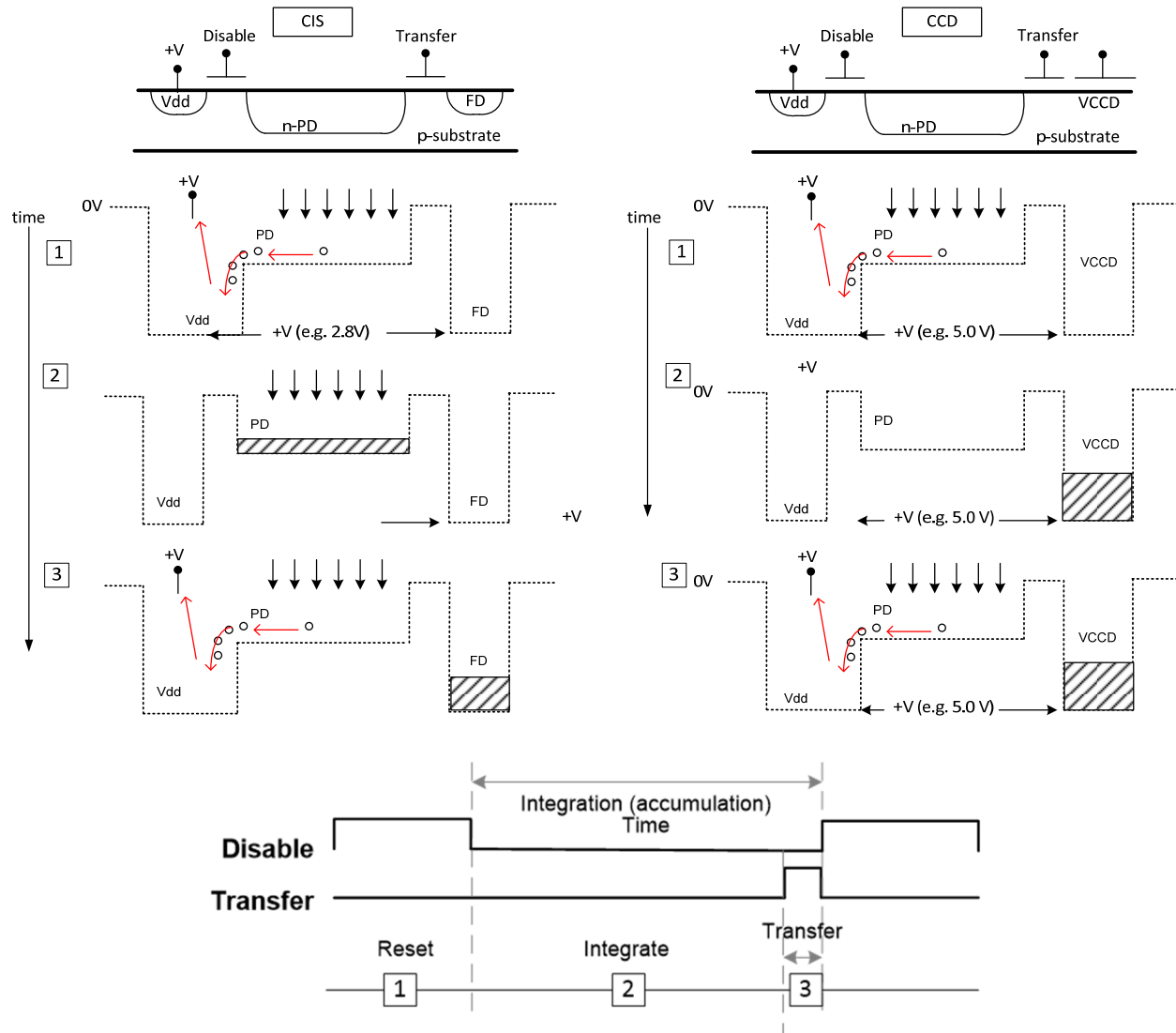
49. Image sensors have the ability to perform electronic shuttering, which obviate the need for a mechanical shutter. An electronic shutter, as illustrated in the figure below, does not have any physical moving parts that open or close, and accomplishes the equivalent of a mechanical shutter by electrically enabling the photodiode to collect photoelectrons formed by incident light for a specified duration of time.



Ex.1021, 17

50. When a photodiode is disabled from collecting light, photoelectrons are still created from incident light, but they are continuously drained from the photodiode to a power supply connection in the pixel. Such periods do not affect the imaging result, and are not considered to be part of the

integration time/exposure time/shutter speed. This is shown in the figures that I created below.



51. Electronic shutter may allow the elimination of the mechanical shutter, thereby reducing the size and cost of the camera, and enabling much shorter (faster) integration times compared to a mechanical shutter. Ex.1008, 2 (Image sensors incorporating an on-chip electronic shutter “for controlling integration time...may allow the elimination of the mechanical shutter.”).

52. The terms “exposure time” and “integration time” are often used interchangeably in the context of an image sensor, and an image sensor with an on-chip electronic shutter controls its exposure time by controlling its integration time. Ex.1028, 1821n.1 (“we use *integration time and exposure time interchangeably*”); Ex.1022, 1:22-24 (“The *exposure or integration time* for the array of photodetectors can be controlled by well known mechanisms.”); Ex.1027, 3:10-12 (“Several images at different *exposures (charge-integration periods)* are acquired and then combined into a single image.”); Ex.1009, 9 (using “short integration time” and “long integration time” to describe images with different exposure times); Ex.1029, 1 (“Electronic shutters are employed in charge-coupled devices (CCDs) to control *integration time (exposure)* of the photodiode array”); Ex.1012, 2 (“*Shuttering*, the ability to *start and stop exposure* arbitrarily. It is a *standard feature* of virtually all consumer and most industrial CCDs”), 4 (“A ‘*rolling shutter*’ can *start and stop exposure* on a CMOS device”).

53. The '158 patent similarly uses “exposure time” to refer to “integration time.” For example, the '158 patent describes “us[ing] a range of *integration times*, T_{long} to T_{short} for each channel,” stating that “sensor camera channel output values P_{short} , to P_{long} , measured *with different exposure times*, of the camera system described below *may not be related ideally* through the ratio ($t = T_{\text{long}}/T_{\text{short}}$)”). Ex.1001, 5:33-54. A POSITA would have understood that its description of

“different exposure times” refers to the different integration times T_{short} and T_{long} , because it describes the relationship of P_{short} and P_{long} corresponding to integration times (exposure times) T_{short} and T_{long} . *See also* Ex.1001, 2:31-34 recognizing that ***“an electronic shutter is used to change the integration time.”***).

VI. THE '158 PATENT

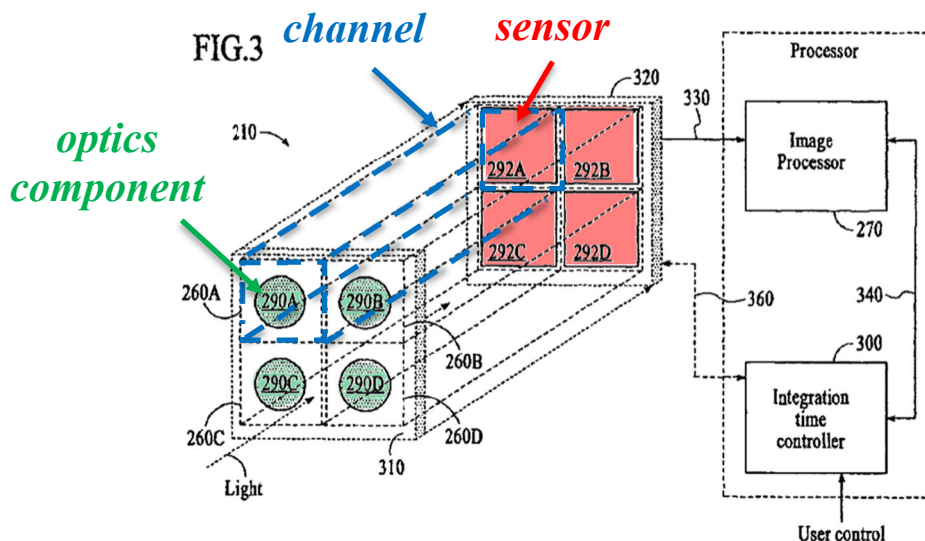
A. Overview

54. The '158 patent is directed to “expanding the dynamic exposure range in digital cameras.” Ex.1001, 1:26-28. The '158 patent acknowledges it was known that the “[intra-scene] dynamic range of an image sensor can be increased by using multiple...integration times.” Ex.1001, 1:57-58. “Integration time” refers to “the time the image sensor collects and integrates [the] signal from the scene.” Ex.1001, 4:3-6. In other words, integration time refers to the charge accumulation time of the sensor, and “upon completion of the integration period...the accumulated charge [is transferred] as a photo-signal to a processing component.” Ex.1001, 4:50-56. Integration time affects the exposure of a scene, e.g., darker objects are better captured with a longer integration time, and brighter objects are better captured with a shorter integration time. Ex.1001, 5:40-54. The '158 patent asserts that known techniques of increasing the intra-scene dynamic range by using multiple integration times may “exhibit undesirable temporal aliasing” e.g., causing artifacts like ghosting or blurring due to inconsistent capturing of a fast-

moving object, because the images are “captured using the same image sensor and thus are not captured concurrently.” Ex.1001, 1:57-2:5.

55. The '158 patent attempts to solve this issue by using a digital camera system including “two or more camera channels,” where “[e]ach channel includes an optics component and an image sensor.” Ex.1001, 3:41-45. By having “two or more camera channels,” “[t]he images obtained in each channel under the different integration times are obtained simultaneously or nearly simultaneously, so undesirable temporal aliasing from moving scenes or camera motion is minimized.” Ex.1001, 3:53-57.

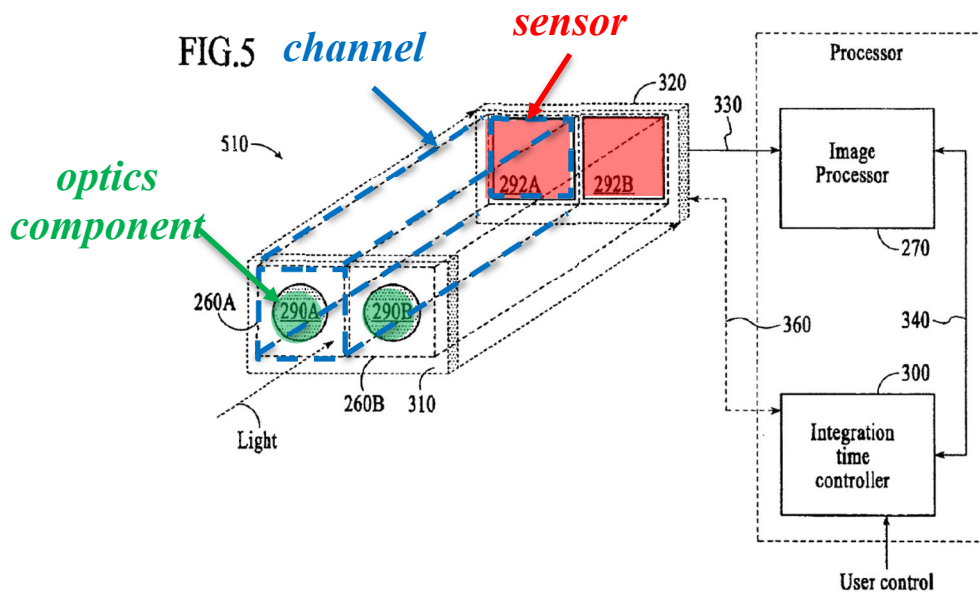
56. FIG. 3 below illustrates an embodiment having four camera channels 260A-260D. In this embodiment, “each camera channel may be used to detect a different color (or band of colors) and/or band of light than that detected by the other camera channels.” Ex.1001, 8:49-52.



Ex.1001, FIG. 3, annotated.

57. The FIG. 3 embodiment includes a digital camera subsystem 210 having “four camera channels 260A-260D,” each respectively including an optics component (290A-290D) and a corresponding sensor component (292A-292D), such that there is a one-to-one relationship between the optics component (e.g., optics component 290A) and the sensor (e.g., sensor 292A) that form a channel (e.g., channel 260A). Ex.1001, 7:17-39.

58. FIG. 5 below illustrates another embodiment with two camera channels 260A and 260B, each “configured for RGB [red, green and blue] light.” Ex.1001, 10:37-40.

**Ex.1001, FIG. 5, annotated.**

59. The '158 patent states, “Exposure is the total amount of light allowed to fall on a sensor during the process of taking a photograph. Exposure control is

control of the total amount of light incident on a sensor during the process of taking a photograph. In contrast to exposure control, which is used by conventional digital cameras to manage dynamic range, the digital camera systems of an embodiment use integration time control to control the time the electrical signal is integrated on a charge storage device (capacitance) within a sensor (pixel).”

Ex.1001, 4:37-46. A POSITA would have understood here the ’158 patent’s description of “in contrast to exposure control” means “in contrast to exposure control by mechanical shutters,” because it was well-known in that art that “integration time control” controls exposure time of the sensor and is also a technique for exposure control. Ex.1009, 9; Ex.1013, [0024] (“It is to be noted that in a camera having a mechanical shutter used to control the length of time over which the light flux enters the image-capturing element 6, the length of time over which the shutter remains open is equivalent to the shutter speed. In a camera having an electronic shutter used to control the length of time over which charges are stored at the image-capturing element 6, the length of time over which the electrical charges are stored at the image-capturing element 6 is equivalent to the shutter speed.”); *see also*, Ex.1001, 5:46-49 (describing its use of different integration times for “combin[ing] the output signals of **both exposures** to increase the dynamic range of the digital camera”), 5:50-54 (referring its different integration times T_{long} and T_{short} as “**different exposure times**”).

B. Prosecution History

60. The '158 patent was filed as U.S. Application 14/063,236. It claims priority to five parent applications and three provisional applications. Ex.1002, 168-169; Exs.1030-1034 (prosecution histories of five parent applications).

61. During prosecution of the earliest parent application (abandoned), the Examiner rejected claims (e.g., claim 12 reciting “the first array of photo detectors and the second array of photo detectors are disposed in the same image plane”) that are substantively different from the Challenged Claims based on prior art combinations that included Yu. Ex.1030, 1-2, 18, 21, 527. In the following four parent applications, Yu was cited along with many other references, but was never relied upon by the Office to reject the claims. Ex.1031, 1032, 1033, and 1034.

VII. CLAIM CONSTRUCTION

62. It is my understanding that in order to properly evaluate the '158 patent, the terms of the claims must first be interpreted. It is my understanding that for the purposes of this *inter partes* review, the claims are to be construed under the so-called *Phillips* standard, under which claim terms are given their ordinary and customary meaning as would be understood by one of ordinary skill in the art in light of the specification and prosecution history, unless the inventor has set forth a special meaning for a term.

63. I was informed that some terms in the Challenged Claims were

previously construed by the Board in IPR2022-00710 (“Toyota IPR”) and by the Court in *Intellectual Ventures I LLC et al. v. General Motors Company et al.*, WDTX 6:21-CV-1088 (“GM Litigation”). Ex.1002, 14-18; Ex.1015, 46-54. These constructions are summarized below for completeness. However, neither the prior constructions nor the Board’s previous exclusions from the scope thereof are necessary in view of the grounds discussed below.

64. I was informed that the Board in Toyota IPR preliminarily construed the following terms in the Institution Decision in the Toyota IPR. *See* Ex.1002, 19-20.

Term	Board’s Construction
“ <i>wherein each optics component of the plurality of optics components is configured to pass light to a sensor of the plurality of sensors</i> ” (claim 1)	“each of the plurality of optics components is configured to pass light separately to a distinct sensor of the plurality of sensors.” Ex.1002, 19. “this claim element excludes from the scope of claim 1 devices that rely on a common optics component to pass light to multiple camera channels.” Ex.1002, 19.
“ <i>plurality of channels</i> ” (claims 9, 15)	“multiple independent structures that separately pass light to a different respective sensor” Ex.1002, 20. “the plain meaning of this claim element excludes from the scope of claims 9 and 15 devices that rely on a common optics component to pass light to multiple camera channels.” Ex.1002, 20.

65. The grounds discussed below do not rely on a common optics

component to pass light to multiple camera channels, which the Board excluded from the scope of the corresponding claims in the Toyota IPR.

66. I was informed that the Court construed the following terms in the GM Litigation.

Term	Court's Construction
" <i>integration time</i> " (claims 1-3, 8-9, 11, 13-16)	"the time the image sensor collects and integrates signal from the scene" Ex.1015, 49.
" <i>an image capture device</i> " (claim 1)	"a device including a plurality of sensors, where two or more of the plurality of sensors each capture an overlapping portion of the same scene" Ex.1015, 52.

67. The prior art identified in the grounds below render the Challenged Claims obvious in accordance with the prior constructions.

68. For the purposes of my analysis below, I do not believe any claim terms require explicit construction other than the term(s) identified below.

A. "during a frame"² (claim 2)

69. A POSITA would have understood that "*during a frame*" means

² The '158 patent also provides a definition of "frame" related to a physical component of a camera. Ex.1001, 23:44-45 ("Frame' or 'thin plate' means the component of the DCS that is used to hold the lenses and mount to the image sensor."). A POSITA would have understood that this definition does not apply

“during a period of time in which data for a single frame of an image is captured” by a sensor. This period of time includes a period that the sensor is exposed to light and integrates the electronic charges to create that single frame of an image. This construction is supported by the specification, the surrounding claim language, and a POSITA’s knowledge.

70. First, this construction is supported by the specification. The ’158 patent states that “[i]mage capture by the camera is performed using the multiple camera channels, and *each camera channel is controlled during a frame* under an independent integration time.” Ex.1001, 3:47-50; *see also id.*, 11:28-29 (“The photo-signal *from each camera channel is integrated 704 within a single frame of data*”).

71. Second, this construction is supported by the surrounding claim language. Claim 2 recites “*wherein the processing component is further configured to control the integration time of each sensor during a frame.*” A POSITA would have understood that for each particular sensor, the processing component controls the integration time of that particular sensor such that the particular sensor captures data for a single frame of an image. As such, the integration time of the particular

to the term “*during a frame,*” because a physical component is not a time period.

sensor is controlled during a period of time in which data for a single frame of an image is captured by the particular sensor.

VIII. IDENTIFICATION OF HOW THE CLAIMS ARE UNPATENTABLE

72. I have been asked to provide my opinion as to whether the Challenged Claims of the '158 patent would have been obvious in view of the prior art. The discussion below provides a detailed analysis of how the prior art references identified below teach the limitations of the Challenged Claims of the '158 patent.

73. As part of my analysis, I have considered the scope and content of the prior art and any differences between the alleged invention and the prior art. I describe in detail below the scope and content of the prior art, as well as any differences between the alleged invention and the prior art, on an element-by-element basis for each of the Challenged Claims of the '158 patent.

74. As described in detail below, the alleged invention of the Challenged Claims would have been obvious in view of the teachings of the identified prior art references as well as the knowledge of a POSITA. My obviousness analysis relies on the combined teachings of the references and not on a physical incorporation of elements. I apply the prior art as follows:

Ground	Claim	Basis (Pre-AIA)
#1	1-2, 5, 8-9, 11, 13-16, and 19	§ 103 over Matsushima

#2	1-2, 4-5, 8-11, 13-14	§ 103 over Yu in view of Miyazaki
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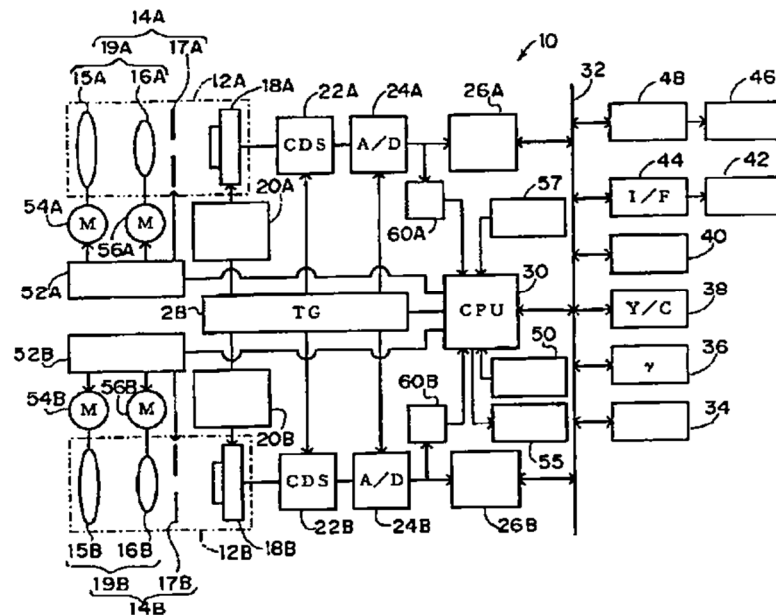
75. As stated above, I have used the earliest possible priority date – August 24, 2004 – for my analysis of this declaration.

A. Ground 1: Claims 1-2, 5, 8-9, 11, 13-16, and 19 Would Have Been Obvious Over Matsushima.

1. Overview of Matsushima

76. Matsushima “relates to a digital camera and, more specifically, to a digital camera equipped with multiple imaging systems.” Ex.1007, [0001]. As shown in FIG. 1 below, Matsushima describes a “digital camera 10 [that] has **two independent imaging systems** (a first imaging system 12A and a second imaging system 12B).” Ex.1007, [0017]. “[I]mages are formed on the light-receiving surfaces of CCD 18A and 18B via imaging optics 14A and 14B, **respectively.**” *Id.*

[FIG. 1]



Ex.1007, FIG. 1.

2. Analysis

a) Claim 1

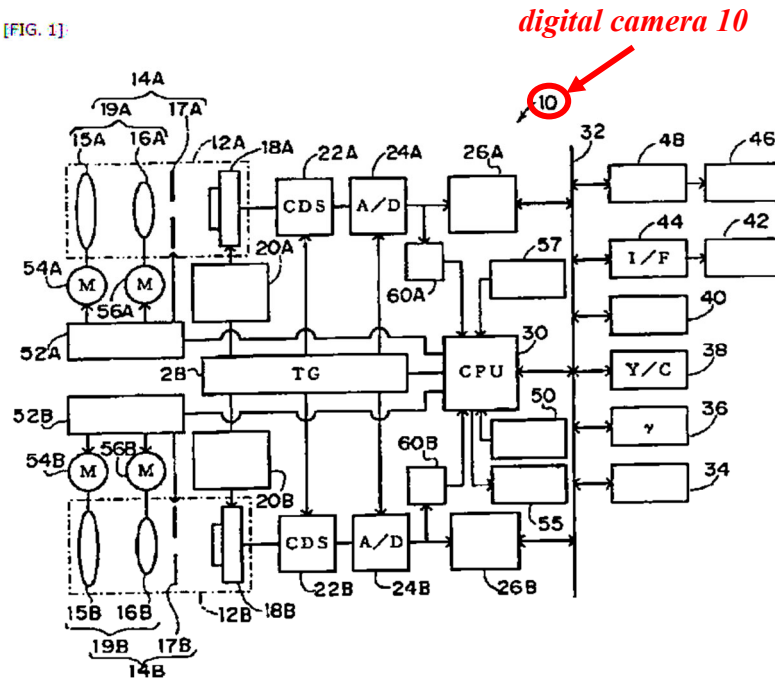
[1.0] An image capture device comprising:

77. To the extent the preamble is limiting, Matsushima discloses or at least renders it obvious.

78. Matsushima “relates to a digital camera and, more specifically, to a digital camera equipped with multiple imaging systems.” Ex.1007, [0001]; *see also* FIG. 1, [0017] (“FIG. 1 is a block diagram showing the configuration of a digital camera. This digital camera 10 has two independent imaging systems (a first imaging system 12A and a second imaging system 12B), and subject images are formed on the light-receiving surfaces of CCD 18A and 18B via imaging optics

14A and 14B, respectively.”).

[FIG. 1]



Ex.1007, FIG. 1, annotated.

79. Further, Matsushima teaches *an imaging capture device* under the construction in the GM Litigation (VII), because Matsushima’s digital camera 10 is a device including a plurality of sensors (CCD 18A and 18B), where two or more of the sensors each capture an overlapping portion of the same scene.

Ex.1007, [0048] (“a captured image 62A taken with the first imaging system 12A [using sensor 18A]” and “a captured image 62B taken with the second imaging system 12B [using sensor 18B]”); FIGS. 2, 3, 4, and 6 illustrating captured images 62A and 62B with an overlapping portion of the same scene.

80. Thus, Matsushima discloses or at least renders obvious *an imaging*

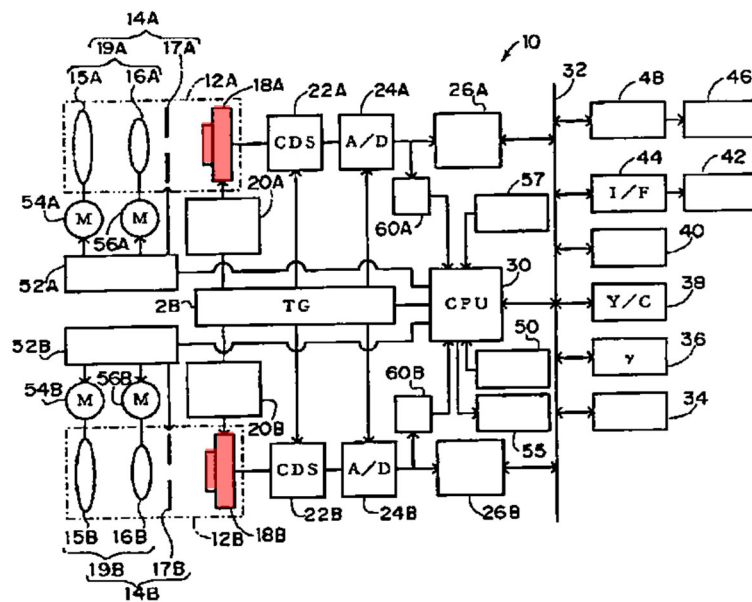
capture device (a digital camera).

[1.1] a plurality of sensors;

81. Matsushima discloses or at least renders obvious limitation [1.1].

82. As shown in annotated FIG. 1 below, Matsushima discloses *a plurality of sensors* (CCD 18A and 18B). Ex.1007, [0017]. CCD image sensors were a well-known type of image sensor. Ex.1009, 2 (describing “CCD (Charge Coupled Device) image sensors”).

[FIG. 1] *a plurality of sensors*



Ex.1007, FIG. 1, annotated.

83. Specifically, Matsushima discloses “[a] digital camera comprising: a first imaging system including *a first image sensor*...; a second imaging system including *a second image sensor*.” Ex.1007, [Claim 1]; [0022] (“CCD 18A corresponds to the first image sensor[, and] CCD 18B corresponds to the second

image sensor.”); *see also id.*, [0017] (“subject images are formed on the light-receiving surfaces of *CCD 18A and 18B* via imaging optics 14A and 14B, respectively.”); [0021] (“CCD 18A and CCD 18B can be, for example, CCDs of the same size, that is, the same number of pixels”).

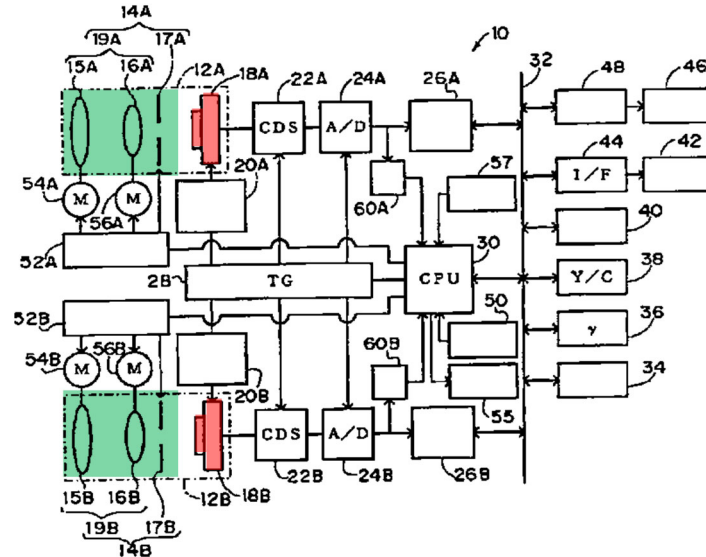
84. Thus, Matsushima discloses limitation [1.1].

[1.2] a plurality of optics components, wherein each optics component of the plurality of optics components is configured to pass light to a sensor of the plurality of sensors; and

85. Matsushima discloses or at least renders obvious limitation [1.2].

86. As shown in annotated FIG. 1 below, Matsushima discloses *a plurality of optics components* (imaging optics 14A (and/or each optics component thereof including a first lens group 19A with an imaging lens 15A and a focus lens 16A, and an aperture 17A) and imaging optics 14B (and/or each optics component thereof including a second lens group 19B with an imaging lens 15B and a focus lens 16B, and an aperture 17B)). Ex.1007, [0017], [0019]. In Matsushima, *each optics component of the plurality of optics components is configured to pass light to a sensor* (imaging optics 14A configured to separately pass light to a distinct image sensor 18A, imaging optics 14B configured to separately pass light to a distinct image sensor 18B) *of the plurality of sensors* (image sensors 18A and 18B). Ex.1007, [0017], [0019].

*each optics component
... configured to [separately]
pass light to a [distinct] sensor*
[FIG. 1]



Ex.1007, FIG. 1, annotated.

87. In Matsushima, each of imaging optics 14A (and the optics components thereof including a first lens group 19A with an imaging lens 15A and a focus lens 16A, and an aperture 17A) and imaging optics 14B (and the optics components thereof including a second lens group 19B with an imaging lens 15B and a focus lens 16B, and an aperture 17B) teaches an *optics component*. Ex.1007, [0019].

88. Further, in Matsushima, *each optics component of the plurality of optics components* (imaging optics 14A and the optics components thereof, and imaging optics 14B and the optics components thereof) *is configured to pass light separately to a distinct sensor of the plurality of sensors*, because “subject images

are formed on the light-receiving surfaces of CCD 18A and 18B via imaging optics 14A and 14B, **respectively**.” Ex.1007, [0017]; [0023]. Imaging optics 14A and imaging optics 14B are in “two **independent** imaging systems...12A and 12B,” and are configured to separately pass light to respective and distinct image sensors 18A and 18B of their corresponding independent imaging systems 12A and 12B. Ex.1007, [0017].

89. Thus, Matsushima discloses or at least renders obvious limitation [1.2].

[1.3] a processing component configured to control an integration time of each sensor.

90. Matsushima discloses or at least renders obvious limitation [1.3].

91. The '158 patent makes clear that *integration time* is charge accumulation time. Ex.1001, 4:46-50 (“[i]ntegration time control...controls the time the electrical signal is integrated or accumulated”), 4:50-56 (“the charge integration switch is placed in a state to allow charge to accumulate within the sensor for a period of time... upon completion of the integration period...the accumulated charge [is transferred] as a photo-signal to a processing component”).

92. This is consistent with the construction in the GM litigation. VII; Ex.1001, 4:5-6 (“Integration time” refers to “the time the image sensor collects and integrates signal from the scene.”). The '158 patent background also acknowledges that “integration time” is controlled with an “electronic shutter,” as is similarly

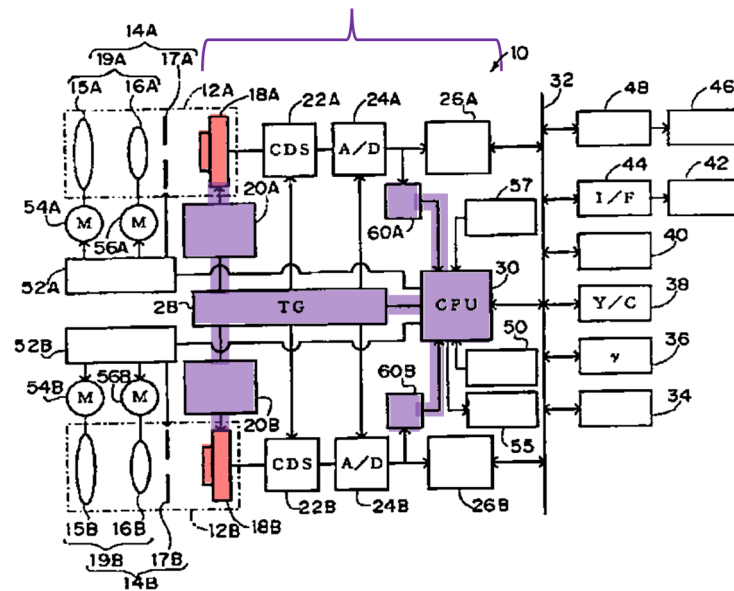
described in Matsushima. Ex.1001, 2:31-34.

93. This description of integration time as synonymous with charge accumulation time is consistent with a POSITA's understanding. Ex.1036 (generally using "charge accumulation period" and "integration time" interchangeably throughout), 14:1-3 ("the charge accumulation (light integration) time period for accumulation of charges by the photosensor array"), 25:41-42 ("the charge accumulation (integration time) period"); Ex.1037, 3:35 ("a charge accumulation (integration) period"), 52 ("a charge accumulation (integration) period"), 4:16 ("integration (accumulation) time").

94. As shown in FIG. 1 below, Matsushima discloses *a processing component* (CPU 30 together with integration circuits 60A and 60B, Timing Generator (TG) 28 and CCD drive circuits 20A and 20B) *configured to control an integration time* (charge "accumulation time (shutter speed)") *of each sensor* (sensors 18A and 18B) using an electronic shutter. Ex.1007, [0027], [0034].

*a processing component configured to
control an integration time of each sensor*

[FIG. 1]



Ex.1007, FIG. 1, annotated.

95. Matsushima explains that the CPU 30 controls charge accumulation time (i.e., *integration time*) with an electronic shutter on each sensor:

CCD 18A and CCD 18B each have a shutter drain via a shutter gate, and the accumulated signal charges can be swept to the shutter drain by driving the shutter gates with shutter gate pulses. In other words, the CCDs 18 have a **so-called electronic shutter function that controls the accumulation time (shutter speed) of the charge accumulated by each sensor** via shutter gate pulses.

Ex.1007, [0024]; *see also id.*, [0034] (“The apertures 17A and 17B are driven via the drive circuits 52A and 52B, and the CCD 18A and CCD 18B **charge accumulation time is controlled using an electronic shutter** to reach the

determined shutter speed.”); [0035], [0027] (describing the CPU 30 controlling the “timing signal generating circuit (TG) 28 [that] provides appropriate timing signals to the CCD drive circuits 20A and 20B”). This description in Matsushima of the sensors collecting and accumulating charge is consistent with the previous construction of “*integration time*” in the GM Litigation. Ex.1015, 49 (“the time the image sensor collects and integrates signal from the scene”).

96. Matsushima further explains that automatic exposure adjustments (AE) is performed by the CPU 30 by controlling the shutter speed (charge accumulation time) of the electronic shutter. Ex.1007, [0028] (“CPU 30 is the control unit that performs overall control of each circuit in the digital camera 10.”); Ex.1007, [0029] (“CPU 30...performs automatic exposure adjustments (AE).”); Ex.1007, [0034] (for automatic exposure (AE) adjustment, the integration circuits 60A and 60B determine the subject luminance (imaging EV value) for sensors (CCD) 18A and 18B respectively, and CPU 30 determines “aperture value and **shutter speed**... based on this imaging EV value.”).

97. Accordingly, in Matsushima, *a processing component* (CPU 30 together with integration circuits 60A and 60B, Timing Generator (TG) 28 and CCD drive circuits 20A and 20B) is *configured to control* (using an electronic shutter of each sensor) *an integration time* (charge accumulation time) *of each sensor* (sensors 18A and 18B) by controlling the sensor’s electronic shutter, which

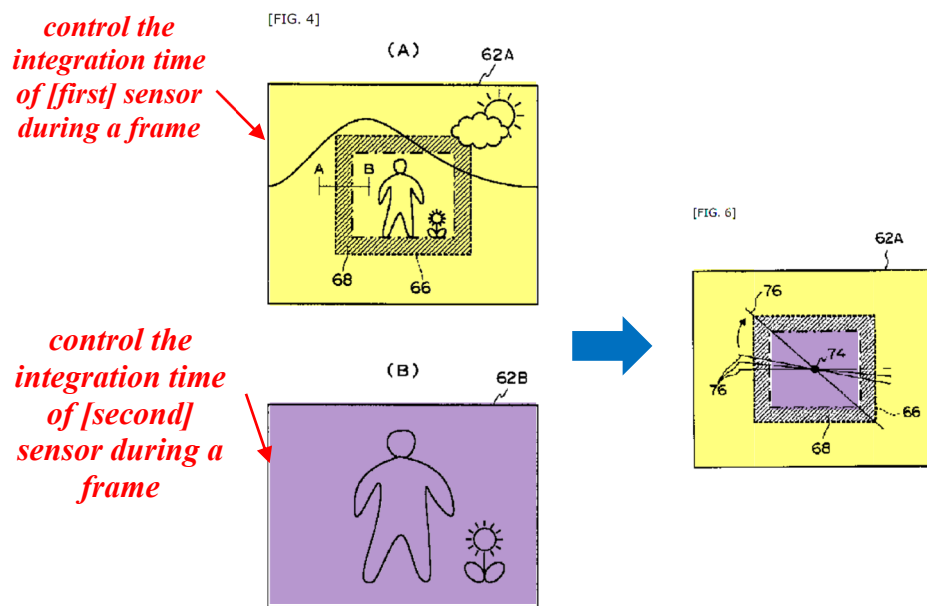
achieves optimal exposure adjustment for each of the sensor. Ex.1007, [0024].

98. Further, as explained at [5.0] and [11.0], Matsushima provides improved image quality with a broad dynamic range, by combining images 62A and 62B having different integration times for different regions in a scene. Ex.1007, [0048]-[0049], [0034].

99. Matsushima's teaching is consistent with well-known knowledge in the art, supported by numerous contemporaneous documents including many from Fujifilm (the assignee of Matsushima), that in an image capture device like Matsushima, *a processing component* (a CPU together with integration circuits, timing Generator (TG), and CCD drive circuits) is configured to controls *the integration time* (charge accumulation time) *of each sensor* (CCD image sensor), e.g., using the respective CCD driver and/or timing generator. Ex.1011, FIG. 3, 8:45-50 (Fujifilm patent describing that a CPU controls the electronic shutter speed of CCD image sensor using the timing generator); EX.1006, FIGS. 2-3, 5:56-60 ("In addition, the system controller 38 feeds a control signal indicative of an electronic shutter speed to be assigned to the CCD image sensor 14 to the CCD driver 36. In this sense, the system controller 38 has an automatic exposure adjusting function.").

100. Thus, Matsushima discloses or at least renders obvious limitation [1.3].

sensor. As shown in annotated FIGS. 4 and 6 below, Matsushima discloses or at least renders obvious that the control of each sensor as claimed in [1.3] is performed during a period of time in which data for a single frame of an image is captured by that sensor (a single frame of image 62A captured by sensor 18A, and a single frame of image 62B captured by sensor 18B).



Ex.1007, FIGS. 4 and 6, annotated

104. Specifically, Matsushima teaches using sensors 18A and 18B to capture images 62A and 62B of the same scene. Ex.1007, [0048] (“a captured image 62A taken with the first imaging system 12A [using sensor 18A]” and “a captured image 62B taken with the second imaging system 12B [using sensor 18B]”). As discussed at Ground 1:[1.3], an integration time of each sensor is controlled to capture data for its corresponding single frame of an image. Ex.1007,

[0034] (describing controlling an electronic shutter of each sensor for capturing the corresponding single frame of an image). Accordingly, Matsushima discloses that controlling an integration time of sensor 18A during a period of time in which data for a single frame of image 62A is captured by that sensor 18A, and controlling an integration time of sensor 18B during a period of time in which data for a single frame of image 62B is captured by that sensor 18B.

105. Thus, Matsushima discloses or at least renders obvious limitation [2.0].

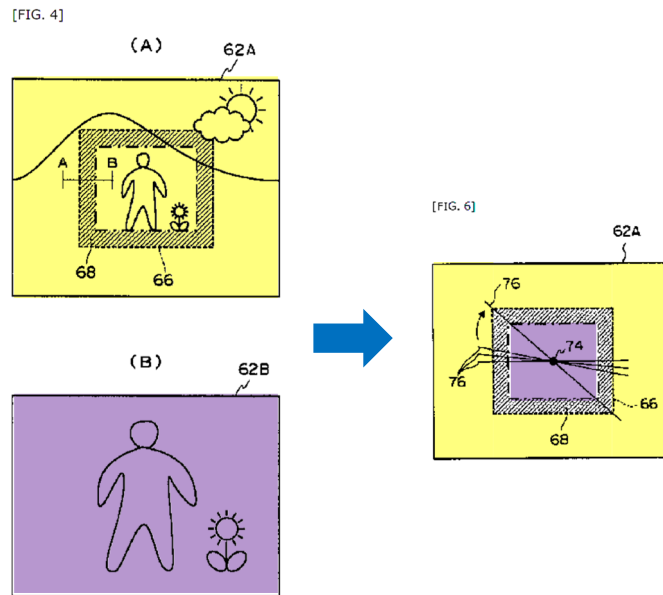
c) Claim 5

[5.0] *The device of claim 1, wherein the processing component is further configured to combine data from the plurality of sensors received to provide an image.*

106. Matsushima discloses or at least renders obvious limitation [5.0].

107. As illustrated in annotated FIGS. 4 and 6 below, Matsushima describes *the processing component* (CPU 30 together with integration circuits 60A and 60B, Timing Generator (TG) 28 and CCD drive circuits 20A and 20B) *configured to combine data* (synthesis processing) *from the plurality of sensors* (sensors 18A and 18B) *received* during the frame (image 62A taken with first imaging system 12A and image 62B taken with second imaging system 1B) *to provide an image* of FIG. 6. Ex.1007, Matsushima, [0048]-[0051] (describing synthesis processing performed on captured images taken by the two imaging

systems).



Ex.1007, Matsushima, FIGS. 4 and 6, annotated.

108. Specifically, Matsushima describes *the processing component* (CPU 30 together with integration circuits 60A and 60B, Timing Generator (TG) 28 and CCD drive circuits 20A and 20B) *configured to combine data from the plurality of sensors* (image sensors 18A and 18B) *received* during the frame, because Matsushima's CPU 30 generates a combined image (FIG. 6) by replacing the image in the center of the captured image 62A corresponding to the scaled down image 66, with the scaled down image 66. Ex.1007, [0048].

109. Matsushima's technique improves image quality in the center of the image, and provides a large dynamic range because image 62A and image 62B are captured with different exposures (with different integration times). Ex.1007,

[0048]-[0049] (“[B]y synthesizing a captured image 62A taken with the first imaging system 12A with a captured image 62B taken with the second imaging system 12B, an image with improved image quality in the center of the captured image is generated....*[B]oth images are synthesized by replacing the image in the center of the captured image 62A corresponding to the scaled down image 66, with the scaled down image 66. This improves image quality in the center of the image.*”).

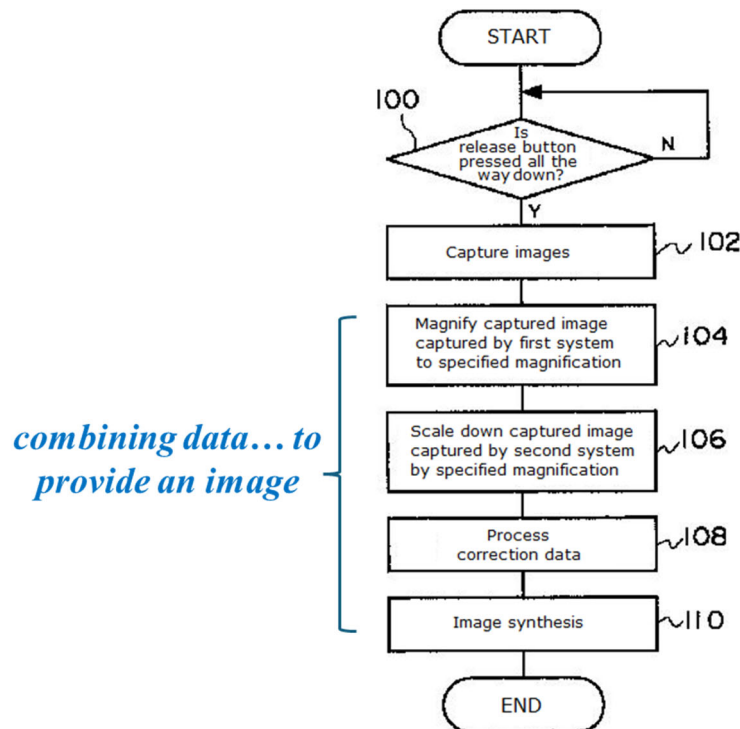
110. Furthermore, Matsushima describes *the processing component* (CPU 30 together with integration circuits 60A and 60B, Timing Generator (TG) 28 and CCD drive circuits 20A and 20B) *configured to combine data from the plurality of sensors received* during the frame, because Matsushima’s CPU 30 combines data from first and second sensors (image sensors 18A and 18B) to generate correction data for peripheral region 68, which achieves continuity of image data around the peripheral regions, to provide a natural boundary between the two images.

Ex.1007, Matsushima, [0050]-[0051] (“However, simply replacing the image in the center of the captured image 62A with the scaled down image 66 may result in an unnatural boundary between the two images, which may cause a deterioration in image quality....*Correction data* is generated to correct the image in the peripheral regions 68 *based on the image data in the peripheral region 68 (shaded region) of the scaled down image 66 and the image data in the peripheral region 68 of the*

captured image 62A. This correction data is then used as the image data for the peripheral regions 68. This prevents unnaturalness from occurring at the boundary between the captured image 62A and the scaled down image 66, preventing a deterioration in image quality.”).

111. As illustrated in FIG. 7 below, Matsushima describes steps for *combin[ing] data from the plurality of sensors received* during the frame (performing synthesis of the images captured at step 102). Ex.1007, Matsushima, FIG. 7, [0062], [0067]-[0068] (describing a control routine executed by CPU 30 to combine data from two channels to generate correction data, and generate a combined image by (1) replacing the image in the center of the wider FOV image with the narrower FOV image and (2) replacing the peripheral region with the correction data).

[FIG. 7]

**Ex.1007, Matsushima, FIG. 7, annotated.**

112. Thus, Matsushima discloses or at least renders obvious limitation [5.0].

d) Claim

[8.0] The device of claim 1, wherein the integration time is controlled based on incident light level.

113. Matsushima discloses or at least renders obvious limitation [8.0].

114. As discussed at Ground 1:[1.3], in Matsushima, *the integration time* (charge accumulation time/shutter speed) *is controlled based on incident light level* (subject luminance/imaging EV value for each sensor). Ex.1007, [0034] (“For AE

control, *the subject luminance (imaging EV value)* is determined based on integration of the R, G, and B signals in a single frame by the integration circuits 60A and 60B, and the aperture value and *shutter speed are determined based on this imaging EV value.*”), [0035] (“During imaging and recording, the AF operation is performed when the release button is ‘half-pressed,’ and *the metering operation is repeated several times to obtain the exact imaging EV.* The final aperture value and *shutter speed for imaging is then determined based on the imaging EV.*”).

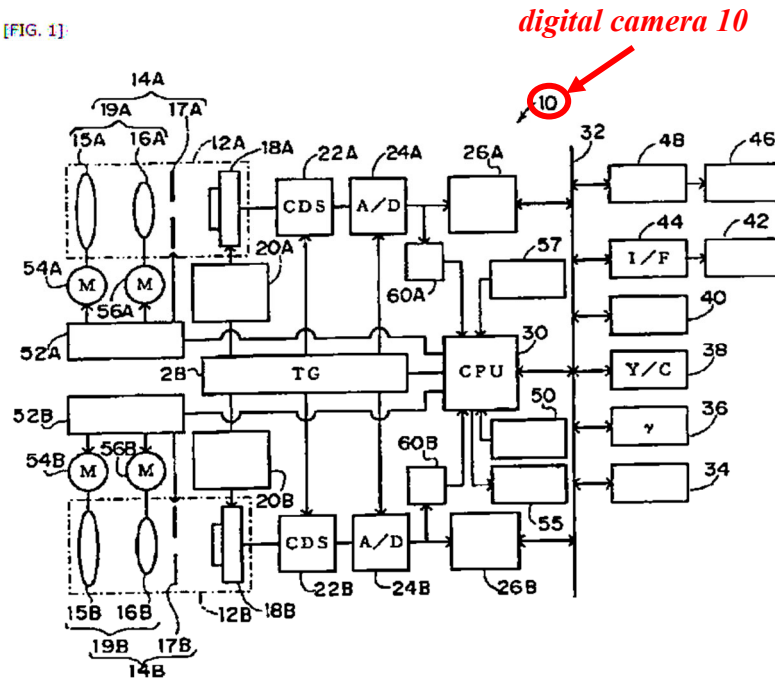
115. Thus, Matsushima discloses or at least renders obvious limitation [8.0].

e) Claim 9

[9.0] A system comprising:

116. Matsushima discloses or at least renders obvious the preamble, because Matsushima discloses *a system* (a digital camera system 10) as discussed above at Ground 1:[1.0], and as shown in FIG. 1 below.

[FIG. 1]



Ex.1007, Matsushima, FIG. 1, annotated.

117. Thus, Matsushima discloses or at least renders obvious the preamble.

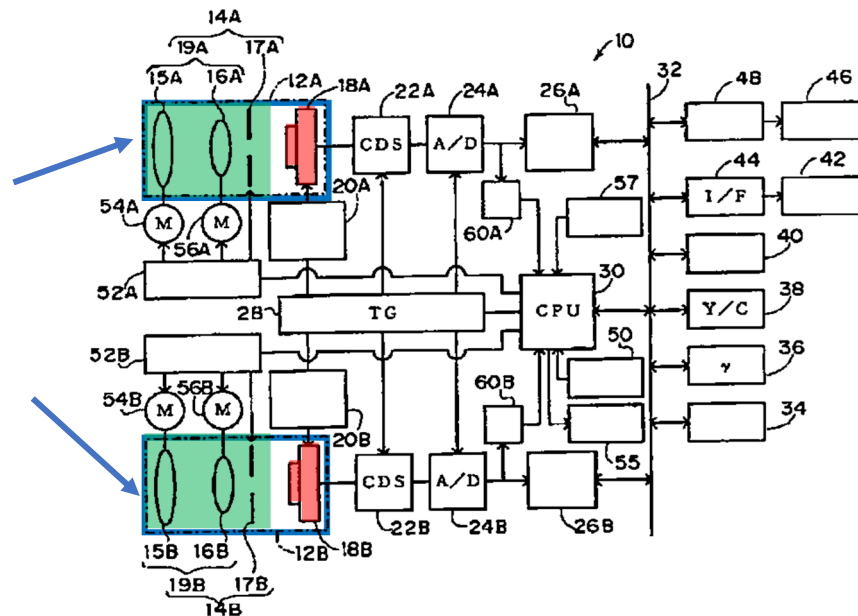
[9.1] a plurality of channels, wherein each channel of the plurality of channels includes a sensor; and

118. Matsushima discloses or at least renders obvious limitation [9.1].

119. Matsushima discloses *a plurality channels* (two channels 12A and 12B), where a first channel (imaging system 12A) includes optics 14A passing light to sensor 18A, and a second channel includes (imaging system 12B) includes optics 14B passing light to sensor 18B. Ex.1007, [0017].

[FIG. 1]

a plurality of channels, wherein each channel of the plurality of channels includes [an independent optics component separately passing light to] a sensor



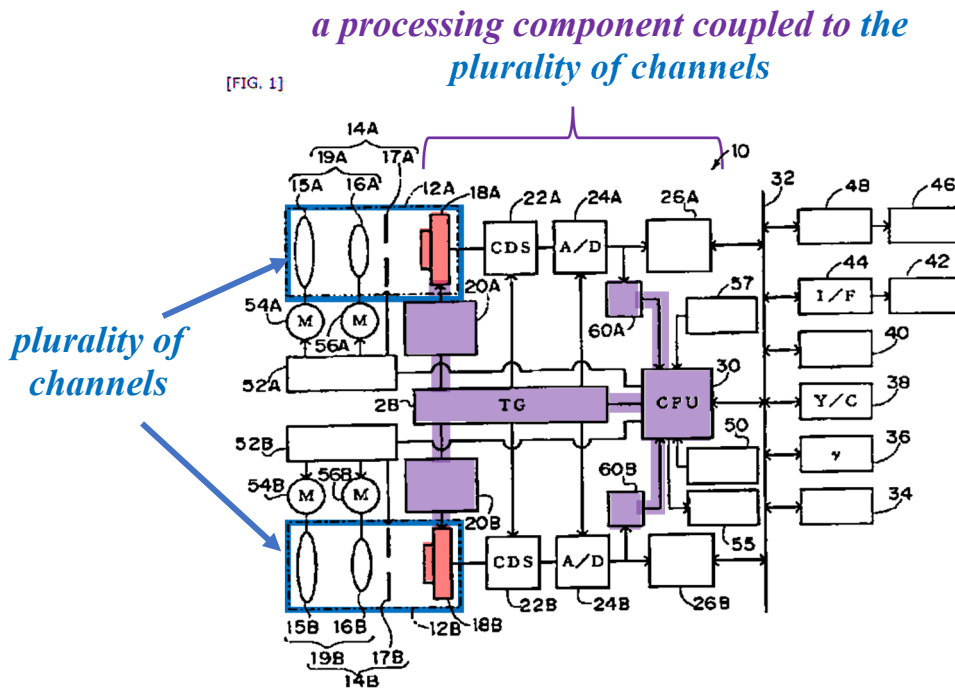
Ex.1007, FIG. 1, annotated.

120. Further, Matsushima teaches a plurality of channels under the construction in Toyota IPR, because Matsushima's plurality of channels separately pass light to a different respective sensor (independent imaging system 12A passing light to sensor 18A, and independent imaging system 12B passing light to sensor 18B).

121. Thus, Matsushima discloses or at least renders obvious limitation [9.1].

[9.2.1] a processing component coupled to the plurality of channels,

122. Matsushima discloses or at least renders obvious limitation [9.2.1].



Ex.1007, Matsushima, FIG. 1, annotated.

123. As shown in annotated FIG. 2 above, Matsushima discloses *a processing component* (CPU 30 together with integration circuits 60A and 60B, Timing Generator (TG) 28 and CCD drive circuits 20A and 20B) *coupled to the plurality of channels* (image systems 12A and 12B, respectively). Ex.1007, [0027], [0034].

124. Thus, Matsushima discloses or at least renders obvious limitation [9.2.1].

[9.2.2] wherein the processing component is configured to determine an integration time of each channel of the plurality of channels,

125. Matsushima discloses or at least renders obvious limitation [9.2.2].

126. As discussed above at Ground 1:[1.3], [8.0], and [9.1], Matsushima

describes that *processing component* (CPU 30 together with integration circuits 60A and 60B, Timing Generator (TG) 28 and CCD drive circuits 20A and 20B) *is configured to determine an integration time* (charge accumulation time) *of each channel* (each of image systems 12A and 12B). Ex.1007, Matsushima, [0027], [0034]. As discussed in Ground 1:[8.0], the integration time is determined based on the incident light level/subject luminance.

127. Thus, Matsushima discloses or at least renders obvious limitation [9.2.2].

[9.2.3] wherein the processing component is configured to combine data from the plurality of channels received to provide an image.

128. Matsushima discloses or at least renders obvious limitation [9.2.3].

129. First, as discussed at Ground 1:[9.1] and [9.2.1], Matsushima discloses or at least renders obvious the plurality of channels, wherein each channel of the plurality of channels includes a sensor, and the processing component coupled to the plurality of channels. Ex.1007, [0017], [0027], [0034], Fig. 1.

130. Second, as discussed at Ground 1:[5.0], Matsushima discloses or at least renders obvious that the processing component is further configured to combine data from the plurality of sensors received to provide an image. Ex.1007, [0048]-[0051], Figs. 4 and 6.

131. Accordingly, Matsushima discloses or at least renders obvious

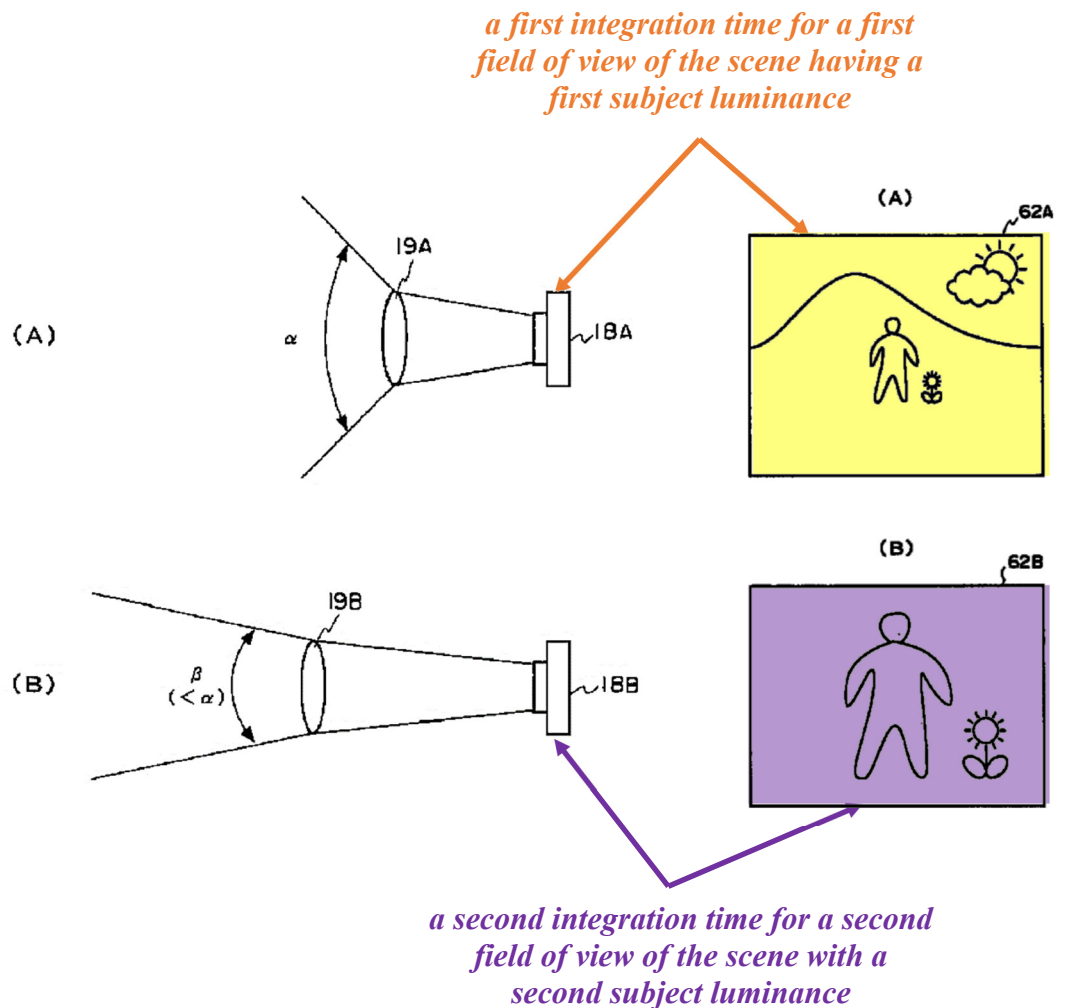
limitation [9.2.3], because in Matsushima, the processing component is configured to combine data from the respective sensors in the plurality of channels to provide an image. Ex.1007, [0017], [0027], [0034], [0048]-[0051], Figs. 4 and 6.

f) Claim 11

[11.0] The system of claim 9, wherein the integration time of at least one channel is relatively shorter than the integration time of at least one other channel.

132. Matsushima renders obvious limitation [11.0].

133. As discussed above at Ground 1:[1.3] and [9.1] and shown in annotated FIGS. 2 and 3 below, Matsushima in view of a POSITA's knowledge renders obvious that *the integration time of at least one channel* (e.g., imaging system 12A with wider FOV with a higher subject luminance) *is relatively shorter than the integration time of at least one other channel* (e.g., imaging system 12B with narrower FOV with a lower subject luminance). Ex.1007, [0020].



Ex.1007, FIGS. 2 and 3, annotated.

134. Specifically, Matsushima describes capturing images with different field of views (different shooting angles α and β) using two channels (independent imaging systems 12A and 12B) respectively. Ex.1007, [0017]. A POSITA would have understood that in Matsushima, the integration times of the image sensors would have different values for different subject luminance of different FOVs. This is because the first subject luminance of the shooting angle α and the second subject luminance of the shooting angle β are determined independently (by

integration circuits 60A and 60B). Ex.1007, [0034]. For example, the first sensor imaging the larger FOV (see 62A including the sun, the sky and other background objects) has a different subject illuminance (e.g., a higher subject illuminance) from the second sensor imaging the smaller FOV (see 62B including a person and a flower), thereby a different integration time (e.g., a shorter integration time) is determined for the first sensor. A broad dynamic range is achieved by combining images 62A and 62B having different integration times for different regions in a scene. As I discussed at V.B.2, expanding intra-scene dynamic range using images with different integration times were well-known. Ex.1009, 9; Ex.1024, 3; Ex.1025, 7, FIG. 8; Ex.1026, 1; *see also* Ex.1001, 1:57-58.

135. Thus, Matsushima renders obvious limitation [11.0].

g) Claim 13

[13.0] *The system of claim 9, wherein the processing component is configured to automatically control the integration time of each sensor.*

136. Matsushima discloses or at least renders obvious limitation [13.0].

137. As discussed above at Ground 1:[1.3] and [8.1], in Matsushima, *the processing component* (CPU 30 together with integration circuits 60A and 60B, Timing Generator (TG) 28 and CCD drive circuits 20A and 20B) *is configured to automatically control* (using automatic exposure control to control an electronic shutter of each sensor) *the integration time* (charge accumulation time/shutter speed) *of each sensor* based on incident light level (subject luminance/imaging EV

value for each sensor). Ex.1005, [0029] (“The CPU 30 controls the corresponding circuit blocks based on signals inputted from a control panel 50, controls the zooming operations of the imaging lenses 15A and 15B and the autofocusing (AF) operations of the focus lenses 16A and 16B, and *performs automatic exposure adjustments (AE).*”), [0034] (“For AE control, the subject luminance (imaging EV value) is determined based on integration of the R, G, and B signals in a single frame by the integration circuits 60A and 60B, and the aperture value and shutter speed are determined based on this imaging EV value.”); [0035] (“During imaging and recording, the AF operation is performed when the release button is ‘half-pressed,’ and the metering operation is repeated several times to obtain the exact imaging EV. The final aperture value and shutter speed for imaging is then determined based on the imaging EV.”).

138. Thus, Matsushima discloses or at least renders obvious limitation [13.0].

h) Claim 14

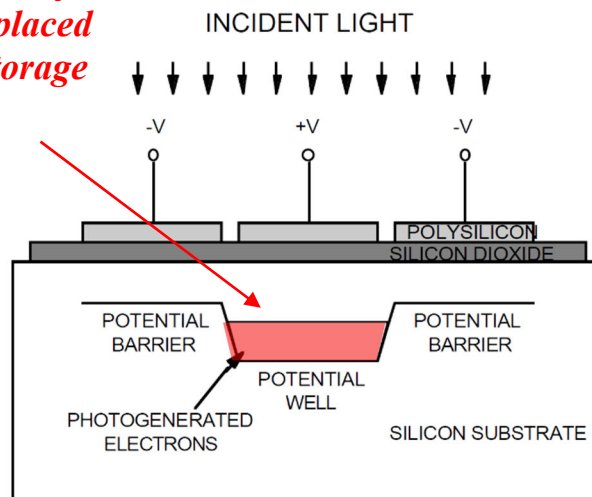
[14.0] The system of claim 9, wherein the integration time is used to control an amount of electrical charge placed on one or more storage devices associated with a sensor.

139. Matsushima discloses or at least renders obvious limitation [14.0].

140. As discussed at Ground 1:[1.3], in Matsushima:[1.3], *the integration time (charge accumulation time) is used to control an amount of electrical charge*

(accumulation of charge/electrons) *placed on one or more storage devices associated with a sensor* (photosensitive devices/photodiode array/pixels of the sensor). Ex.1007, [0035] (“the *charge accumulation time* is controlled by the electronic shutters at the determined shutter speed”); [0024] (“the CCDs 18 have a so-called electronic shutter function that controls the accumulation time (shutter speed) of the **charge accumulated by each sensor** via shutter gate pulses”);, [0002] (“The signal charges accumulated by the CCD are *retrieved pixel by pixel*”); Ex.1008, 2 (“In a **CCD imager** with a built in electronic shutter, the entire imager is reset before integration to remove any residual signal in the photodiodes. **The photodiodes then accumulate charge for some period of time.** At the end of the integration period, all charges are simultaneously transferred to light shielded areas of the sensor.”).

control an amount of electrical charge placed on one or more storage devices



Ex.1023, 5, annotated.

141. Thus, Matsushima discloses or renders obvious this limitation.

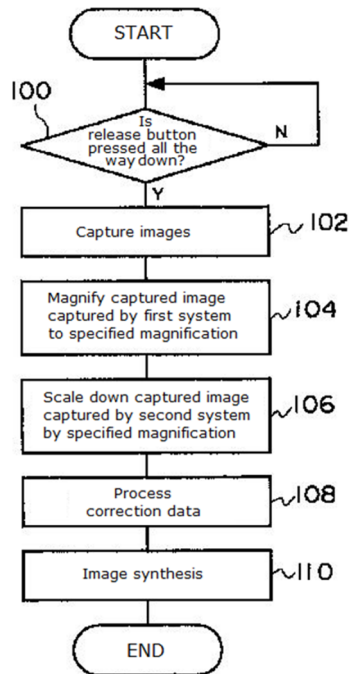
i) Claim 15

[15.0] A method comprising:

142. To the extent the preamble is limiting, Matsushima discloses or renders it obvious.

143. As shown in FIG. 7 below, Matsushima describes a method for capturing images from two independent imaging systems and performing image synthesis to generate an image with improved quality (e.g., improved resolution, expanded dynamic range). Ex.1007, FIG. 7, [0062]-[0069] (describing “the control routine executed by CPU 30 to perform the actions...described with reference to the flowchart in FIG. 7”).

[FIG. 7]

**Ex.1007, Matsushima, FIG. 7.**

144. Thus, Matsushima discloses or renders obvious [15.0].

[15.1] identifying an integration time for each of a plurality of channels of an image capture device, wherein the plurality of channels includes a plurality of sensors;

145. Matsushima discloses or at least renders obvious limitation [15.1].

146. **First**, as discussed at Ground 1:[9.1], Matsushima discloses a plurality channels (independent imaging systems 12A and 12B) of an image capture device (digital camera 10), where the plurality of channels (two channels 12A and 12B) includes a plurality of sensors (sensors 18A and 18B). Ex.1007, [0017].

147. **Second**, as discussed at Ground 1:[1.3] and [8.0], Matsushima

controls *the integration time* (charge accumulation time/shutter speed), which includes *identifying* (determining) *the integration time* (based on incident light level, i.e., subject luminance/imaging EV value) for each of sensors 18A and 18B respectively. Ex.1007, [0034]-[0035].

148. Accordingly, Matsushima describes *identifying an integration time* (determining charge accumulation time for automatic exposure control) *for each of a plurality of channels* (independent imaging systems 12A and 12B) *of an image capture device* (digital camera 10), wherein *the plurality of channels includes a plurality of sensors* (sensors 18A and 18B). Ex.1007, [0034]-[0035], [0017]. Thus, Matsushima discloses or at least renders obvious limitation [15.1].

[15.2] capturing data with each of the plurality of sensors, wherein the data captured by each sensor is based at least in part on the integration time of the sensor; and

149. Matsushima discloses or at least renders obvious limitation [15.2].

150. As discussed at Ground 1:[1.3], [2.0] and [5.0], in Matsushima, the processing component (CPU 30) performs *capturing data* (images 62A and 62B) *with each of the plurality of sensors* (sensors 18A and 18B), *wherein the data captured by each sensor is based at least in part on the integration time of the sensor* (charge accumulation time determined based on subject illuminance with automatic exposure control). Ex.1007, [0034], [0037].

151. Thus, Matsushima discloses or at least renders obvious limitation

[15.2].

[15.3] generating an image by combining the data captured by each of the plurality of sensors.

152. Matsushima discloses or at least renders obvious limitation [15.3] for the same reasons presented above for Ground 1:[5.0].

j) Claim 16

[16.0] The method of claim 15, wherein a first integration time of a first sensor is less than a second integration time of a second sensor.

153. Matsushima renders obvious limitation [16.0] for the same reasons presented above for Ground 1:[11.0].

k) Claim 19

[19.0] The method of claim 15, further comprising separately controlling a parameter of an optics component associated with each channel of a plurality of channels.

154. Matsushima discloses or at least renders obvious limitation [19.0].

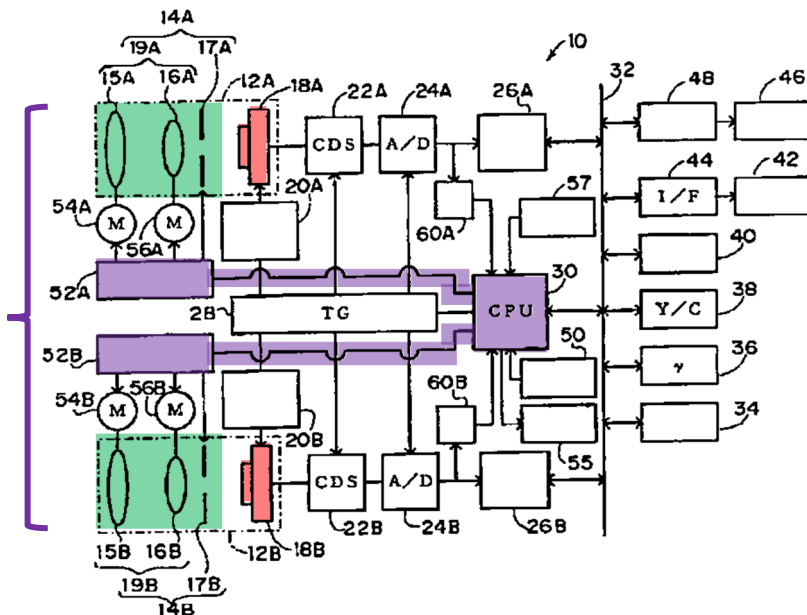
155. As shown in Matsushima's FIG. 1 below, Matsushima describes *separately controlling* (CPU 30 separately controlling first channel 12A with integration circuit 60A and driving circuit 52A with motors 54A and 56A, and separately controlling second channel 12B with integration circuit 60B and driving circuit 52B with motors 54B and 56B) *a parameter of an optics component* (focus position, aperture value, zoom position/FOV) of the digital imaging system.

Ex.1007, [0031]-[0034] (describing CPU 30 separately controlling zoom motors

54A and 54B for controlling zoom position/FOV, and motors 56A and 56B for controlling focus positions and aperture values).

[FIG. 1]

*separately controlling
a parameter of an
optics component
associated with each
channel*



Ex.1007, FIG. 1, annotated.

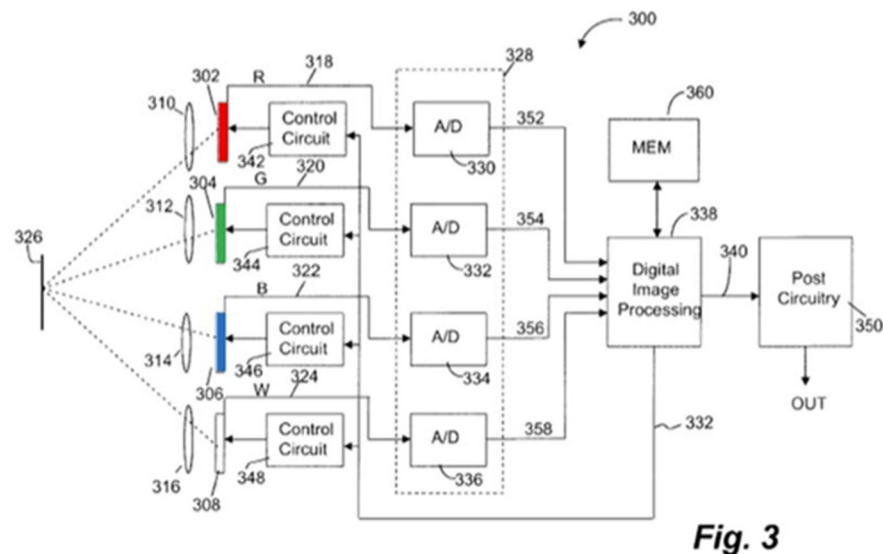
156. Thus, Matsushima discloses or at least renders obvious limitation [19.0].

B. Ground 2: Claims 1-2, 4-5, 8-11, 13, and 14 Would Have Been Obvious Over Yu and Miyazaki.

157. As discussed in Section VI.A, the '158 patent describes an embodiment, relative to FIG. 3, that includes a digital camera with integration times configured for four channels for different bands/spectra of light and thereby provide a large dynamic range imaging capability. Such a digital camera and related methods were well-known in the art, as shown below.

1. Overview of Yu

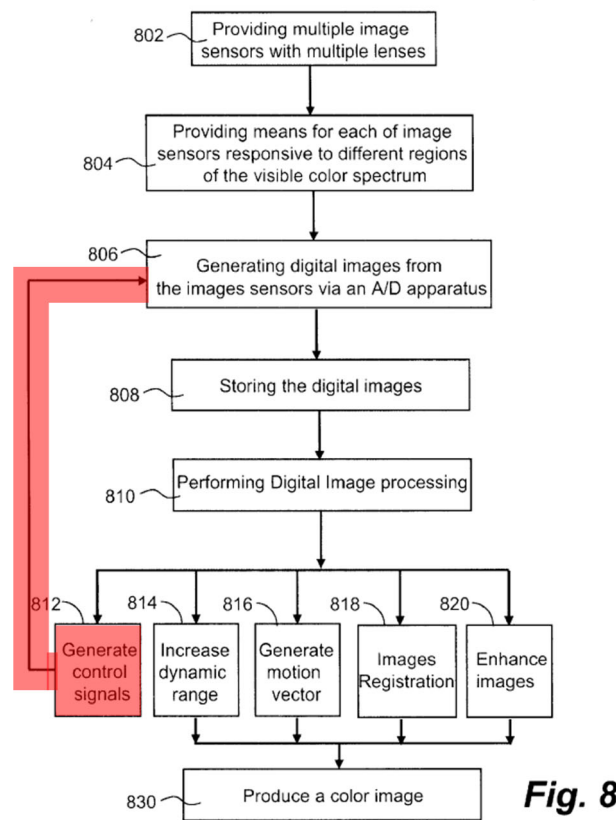
158. Yu is directed to “digital cameras [that] use multiple image sensors with multiple lenses.” Ex.1005, Abstract. As shown in FIG. 3, below, Yu’s “digital camera uses **four image sensors, each having its own lens**, of which three image sensors are made responsive to the three primary colors [red, green, blue] and the fourth one [is] made responsive to all intensity information.” *Id.*, 2:40-44. Yu’s Figure 3, below, is annotated to depict the three image sensors integrated with red, green, and blue color filters (302, 304, and 306, respectively), and the fourth image sensor (308) not integrated with a color filter.



Ex.1005, FIG. 3, annotated.

159. Referring to FIG. 8, below, Yu describes that “each of the image sensors is **respectively and independently controlled** to expose to the same imaging target.” Ex.1005, 9:66-10:1. Yu describes that digital image processing is

performed on the images captured by the sensors, and a color image is produced using the captured images. *Id.*, 10:6-16 (“images...digitized and then stored..., a set of image processes implemented in a DSP chip perform...operations...that include generating control signals..., increasing dynamic range...enhance[ing] images... [and] a true color image with true resolutions is derived from the enhanced images”).

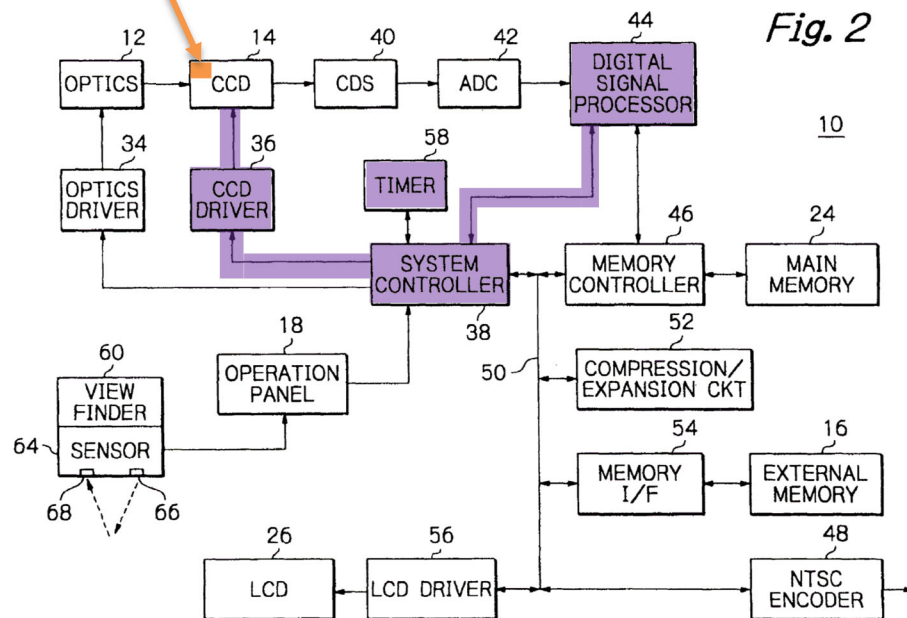


Ex.1005, Fig. 8, annotated.

160. While the analysis herein focuses on Yu’s embodiment including three color sensors with a B/W sensor, the analysis similarly applies to other

2. Overview of Miyazaki

*electronic shutter available
with the image sensor*



Ex.1006, FIG. 2, annotated.

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time. Id., 9:11-14, 47-51; *see also* Ex.1001, 2:31-34 (background explaining that an electronic shutter controls integration time), 4:46-56 (equating that charge accumulation time with integration time); Ex.1008, 2.

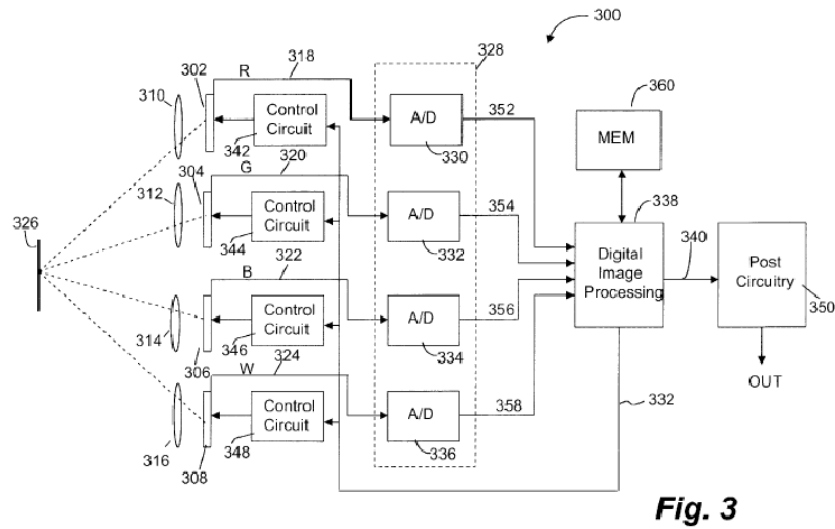
3. Analysis

a) Claim 1

[1.0] An image capture device comprising:

163. To the extent the preamble is limiting, Yu discloses or renders it obvious.

164. Specifically, Yu describes an *image capture device* (a digital camera 300) that “uses four identical image sensors 302, [3]04, 306, and 308” that each image the same scene, as shown in FIG. 3 below. Ex.1005, 4:66-67. “[S]ensed images of target 326 from image sensors 302, 304, 306, and 308 can be digitized in parallel....” Ex.1005, 5:47-49. Yu explains that “each of the image sensors is respectively and independently controlled to expose to the same imaging target.” Ex.1005, 9:66-10:2.

**Fig. 3****Ex.1005, FIG. 3.**

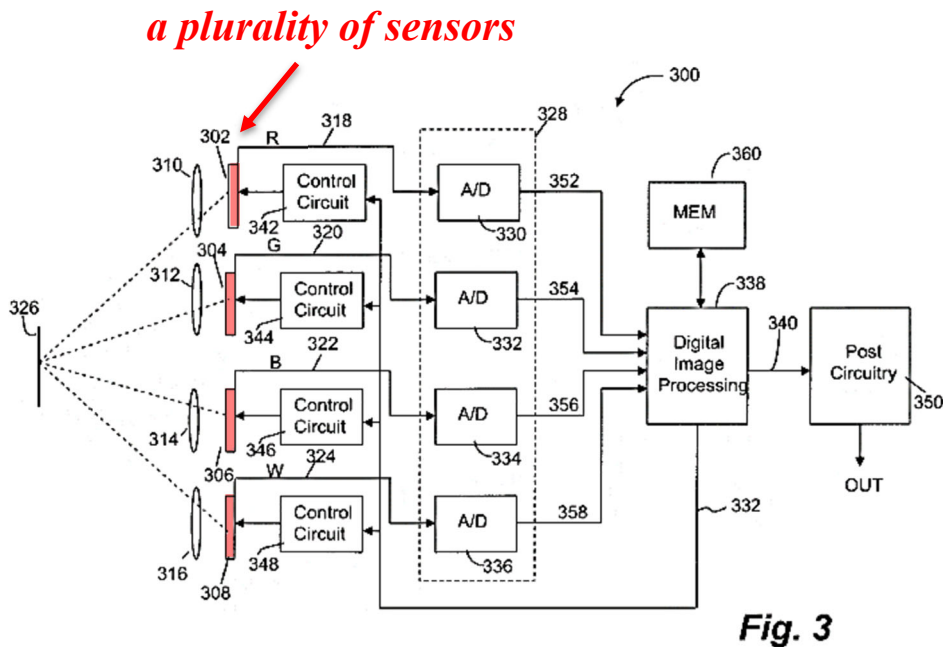
165. Further, Yu teaches *an imaging capture device* under the construction in GM Litigation, because the embodiment illustrated in FIG. 3 (digital camera 300), which includes a plurality of sensors (image sensors 302, 304, 306, and 308) each capture an overlapping portion of the same scene (including target 326), is *an image capture device*.

166. Thus, Yu discloses or at least renders obvious [1.0].

[1.1] a plurality of sensors;

167. Yu discloses or at least renders obvious limitation [1.1].

168. As shown in FIG. 3, below, Yu's imaging system (digital camera 300) includes *a plurality of sensors* ("four identical image sensors 302, [3]04, 306, and 308"). Ex.1005, 4:62-67 ("FIG. 3 shows a block diagram of an improved digital camera 300 employing multiple lens and sensors.").



Ex.1005, FIG. 3, annotated.

169. Thus, Yu teaches *a plurality of sensors* (image sensors 302, 304, 306, and 308).

[1.2] a plurality of optics components, wherein each optics component of the plurality of optics components is configured to pass light to a sensor of the plurality of sensors; and

170. Yu discloses or at least renders obvious limitation [1.2].

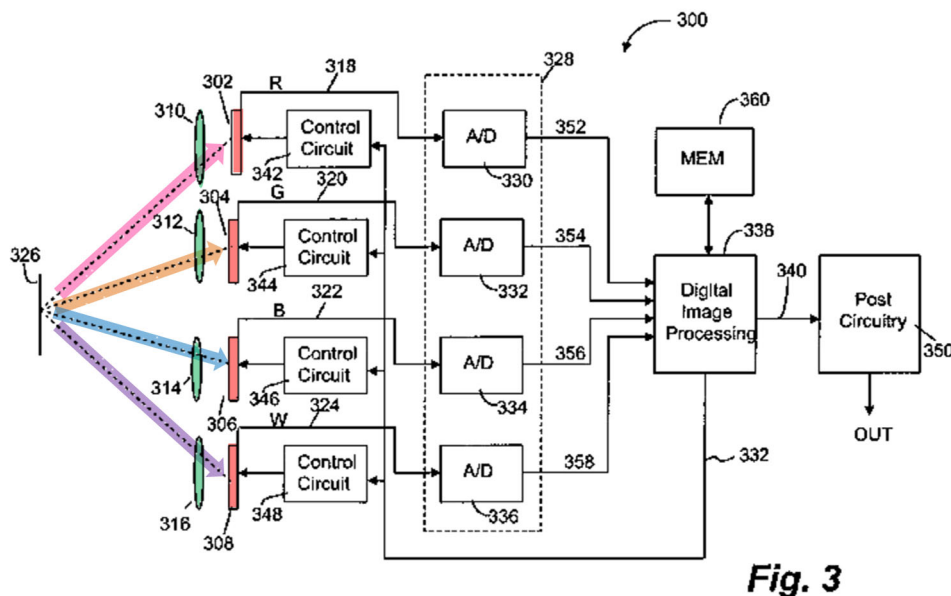
171. First, Yu describes “optical lenses,” which are *optics components*.

Ex.1005, 2:64-65 (“the size of the image sensors could be smaller, resulting in smaller *optical lenses*”). A POSITA would have understood that lenses 310, 312, 314, and 316 in FIG. 3 below, are optical lenses, and therefore that Yu teaches *a plurality of optics components*.

172. The ’158 patent confirms that optical lenses are examples of “*optics*

components.” Ex.1001, 7:23-31, 15:50-53 (“Each of the optics portions 1504A-1504D may include a lens, and may be associated with a respective one of the sensor arrays sensor arrays 1504A-1504D”). Similarly, Yu’s optical lenses 310, 312, 314, and 316, which are associated with respective image sensors 302, 304, 306, and 308 disclose *optics components*, as described and claimed.

each optics component...is configured to pass light [separately] to a [distinct] sensor



Ex.1005, FIG. 3, annotated.

173. Second, as shown in Yu’s FIG. 3 above, each of Yu’s optical lenses 310, 312, 314, and 316 (*each of the plurality of optics components*) is configured to pass light (e.g., from target 326) separately to a distinct sensor of the plurality of sensors (sensors 302, 304, 306, and 308). Ex.1005, 2:40-44 (“an improved digital camera uses four image sensors, *each having its own lens*”); see also Ex.1005,

11:12-13 (“four lenses, each mounted in front of one of the four image sensors”); 11:21-23 (“four image sensors producing, independently and respectively, four intensity images when being exposed to an imaging target.”). Specifically, in FIG. 3 above, lens 310 passes light separately to a distinct sensor 302, lens 312 passes light separately to a distinct sensor 304, lens 314 passes light separately to a distinct sensor 306, and lens 316 passes light separately to a distinct sensor 308. Yu’s system does *not* rely on a common optics component to pass light to multiple camera channels.

174. Thus, Yu teaches a plurality of optics components (lenses 310, 312, 314, 316), wherein each optics component of the plurality of optics components is configured to pass light (from target 326 whose image is being captured) to a sensor of the plurality sensors (e.g., lens 310 passing light separately to a distinct sensor 302, lens 312 passing light separately to a distinct sensor 304, lens 314 passing light separately to a distinct sensor 306, and lens 316 passing light separately to a distinct sensor 308).

[1.3] a processing component configured to control an integration time of each sensor.

175. Yu alone or in view of Miyazaki (Yu-Miyazaki) renders obvious limitation [1.3].

i. Yu alone renders obvious this limitation.

176. As discussed at Ground 1:[1.3], “integration time” refers to “the time

the image sensor collects and integrates signal from the scene,” and is synonymous with charge accumulation time. Ex.1001, 4:5-6; *see also* previous construction in GM Litigation. The ’158 patent background also acknowledges that “integration time” is controlled with an electronic shutter provided on the sensor. Ex.1001, 2:31-34; Ex.1008, 2 (discussing an on-sensor electronic shutter and an external mechanical shutter in front of sensor as alternative techniques for controlling exposure time of a sensor).

177. In prior art literature describing digital cameras, “exposure time” and “integration time” are often used interchangeably in the context of an image sensor with an on-sensor exposure control (e.g., an electronic shutter). Ex.1028, 1821n.1 (“we use *integration time and exposure time interchangeably*”); Ex.1022, 1:22-24; Ex.1027, 3:10-12 (“Several images at different *exposures (charge-integration periods)* are acquired and then combined into a single image.”); Ex.1029, 1; Ex.1012, 2, 4. In a digital camera, an on-sensor electronic shutter does not physically open or close, instead, it controls the exposure time by controlling the sensor’s integration time, which controls how long the image sensor collects and integrates signal from the scene. Ex.1008, 2.

178. As shown in FIG. 3 below, Yu discloses *a processing component* (digital image processing circuitry 338, together with control circuits 342, 344, 346, and 348) configured to control each sensor, including controlling an

integration time (exposure time) of each sensor with its respective on-sensor exposure control.

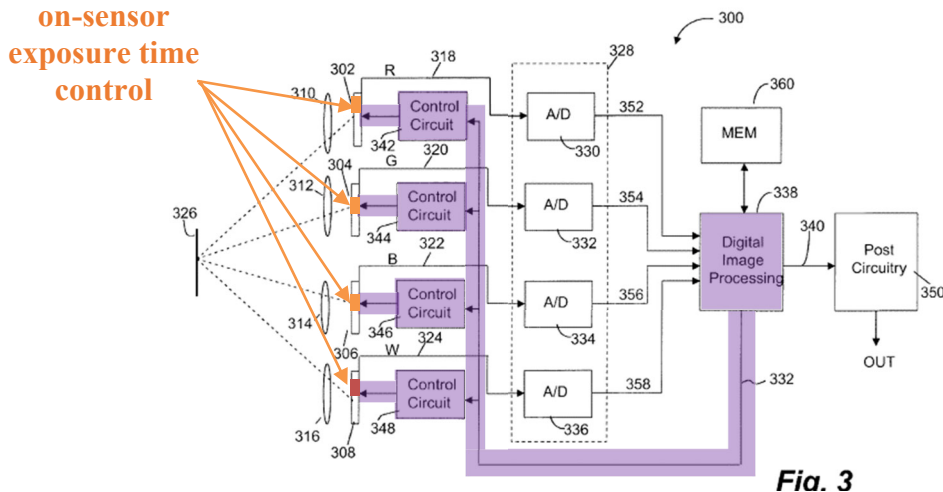


Fig. 3

a processing component configured to control an integration time of each sensor

Ex.1005, FIG. 3, annotated.

179. Specifically, Yu describes its digital image processing circuitry 338 for providing “[a]ll necessary control signals” to control each sensor, including producing control signals “each controlling the exposure time” of each sensor. Ex.1005, 6:59-65 (“All necessary controls signals may be obtained from **digital image processing circuitry 338** that operates on four digital image 352, 354, 356 and 358 respectively and independently resulting from image sensors 302,304, 306 and 308”); Ex.1005, 11:39-42, 12:10-14, 12:16-18 (“said digital image processing circuitry produces four control signals, **each controlling the exposure time of one of said four image sensors** by analyzing respectively said four digital images”), 12:21-23; 9:50-52 (“With images independently from multiple sensors with

multiple lenses, the complementary expansions of the respective dynamic ranges become possible”). Yu describes that “control circuits 342, 344, 346 and 348 receive respectively the control signals 332, each generated with respect to a corresponding histogram in digital image processing circuitry 338 and independently and respectively control image sensors 302, 304, 306 and 308.” Ex.1005, 6:52-58.

180. Accordingly, Yu discloses *a processing component* (digital image processing circuitry 338, together with control circuits 342, 344, 346, and 348) *configured to control each sensor*, where control circuit 342 controls image sensor 302, control circuit 344 controls image sensor 304, where control circuit 346 controls image sensor 306, and control circuit 348 controls image sensor 308. In each case, control of the respective sensor includes independent control of its exposure time.

181. Yu’s “controlling exposure time” of each sensor means “*controlling an integration time*” based on how it describes its control system. Specifically, Yu describes controlling exposure time by sending signals **to the sensors themselves**, rather than controlling a mechanical shutter separate from the sensors.

Ex.1005,12:15-19 (“digital image processing circuitry produces four control signals, each controlling the exposure time of one of said four image sensors”); FIG. 3 (each control circuit 342, 344, 346, and 348 providing an exposure time

control signal to sensors 302, 304, 306, and 308 respectively). In other words, Yu does not control exposure by controlling the amount of time light is allowed to fall upon the sensors using mechanical shutters external to the sensors, but rather controls exposure time by controlling the duration a sensor collects and integrates the electronic signal from the scene, which is also referred to as integration time or charge accumulation period. Ex.1039, 3 (defining “integration time” as “The time or proportion of the operating cycle of the CCD in which charge is accumulated”); Ex.1008, 2 (describing that in CCD image sensors providing an electronic shutter, “[t]he **exposure time** is the time between the reset of the imager and the transfer of charge from the photodiodes to the vertical CCDs,” which is the charge integration time.).

182. This is consistent with the well-known knowledge of POSITA that the terms “exposure time” and “integration time” are often used interchangeably in the context of an image sensor, and an image sensor with an on-chip electronic shutter controls its exposure time by controlling its integration time. Ex.1028, 1821n.1 (“we use **integration time and exposure time interchangeably**”); Ex.1022, 1:22-24 (“The **exposure or integration time** for the array of photodetectors can be controlled by well known mechanisms.”); Ex.1027, 3:10-12 (“Several images at different **exposures (charge-integration periods)** are acquired and then combined into a single image.”); Ex.1009, 9 (using “short

integration time” and “long integration time” to describe images with different exposure times); Ex.1029, 1 (“Electronic shutters are employed in charge-coupled devices (CCDs) to control **integration time (exposure)** of the photodiode array”); Ex.1012, 2 (“**Shuttering**, the ability to **start and stop exposure** arbitrarily. It is a **standard feature** of virtually all consumer and most industrial CCDs”), 4 (“A **‘rolling shutter’ can start and stop exposure** on a CMOS device”).

183. Yu’s disclosure of controlling exposure time at the sensor itself is consistent with the description in the ’158 patent of controlling integration time at the sensor. Ex.1001, 4:46-56 (“Integration time control...controls the time the electrical signal is integrated or accumulated by controlling a switch (e.g., charge integration switch) coupled or connected to the sensor or a photo-detection mechanism of a sensor.”), 5:33-54 (the ’158 patent describing “sensor camera channel output values” with different integration times as “**with different exposure times**”); Ex.1008, 2 (explaining that in digital cameras, the exposure time of an image sensor may be controlled “either by incorporating an external mechanical shutter in front of the image sensor or by incorporating an on-sensor electronic shutter,” and the on-sensor electronic shutter controls the sensor’s exposure time by controlling its integration time); Ex.1028, 1821 n.1, Ex.1022, 1:22-24; Ex.1027, 3:10-12; Ex.1029, 1.

ii. Combination of Yu and Miyazaki (Yu-Miyazaki) renders obvious this limitation.

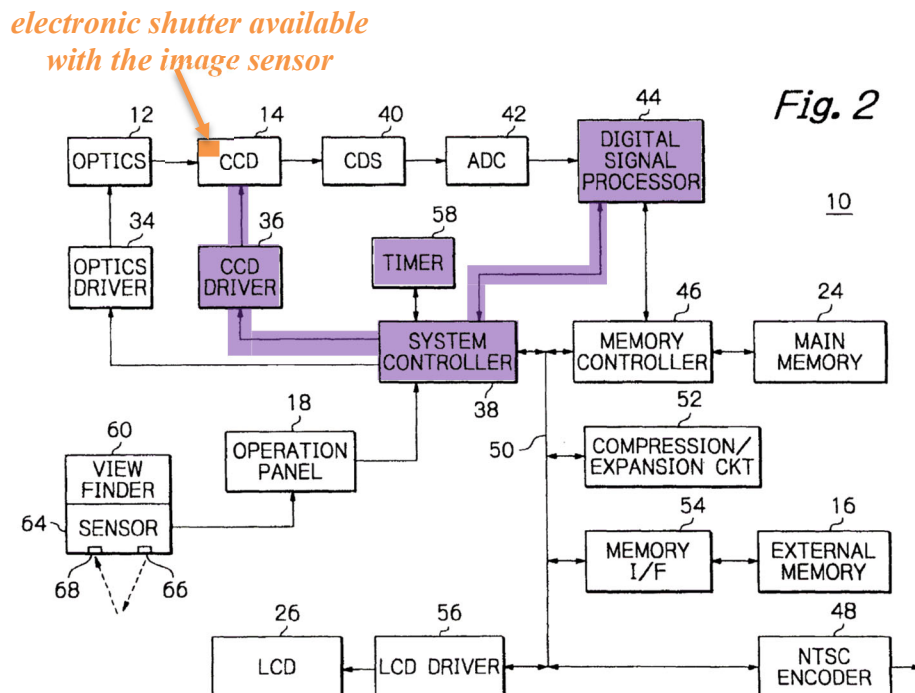
184. To the extent it is argued that Yu's description of using sensor-level exposure time control to control the exposure time of that sensor does not explicitly teach controlling *an integration time of each sensor*, Yu in view of Miyazaki renders this limitation obvious.

185. As illustrated in FIG. 2 below, Miyazaki describes a digital camera 10, in which "the digital signal processor 33 and system controller 38 **control the electronic shutter available with the image sensor 14.**" Ex.1006, 9:48-39. The electronic shutter as described in Miyazaki was a well-known element in digital cameras, which POSITAs referred to as "an on-chip electronic shutter" located on the image sensor and understood is "for controlling integration time" of that sensor. Ex.1008, 2. The '158 patent background also acknowledges that "integration time" is controlled with an "electronic shutter," as described in Miyazaki. Ex.1001, 2:31-34.

186. Consistent with this common understanding, Miyazaki describes that "the [system] controller 38 feeds an electronic shutter control signal to the CCD driver 36 for **controlling the duration of charge storage** in the CCD image sensor 14." Ex.1006, 9:11-14. Consistent with the disclosure of the '158 patent, it was well-known that controlling the duration of charge storage using an electronic shutter is controlling the integration time during which the sensor collects and

integrates/accumulates the electronic charges from photon conversion to generate a signal. Ex.1001, 4:46-56 (describing charge accumulation time as synonymous with integration time); Ex.1007, [0035] (describing that “charge accumulation time is controlled using an electronic shutter”; Ex.1036, 14:1-3, 25:41-42; Ex.1037, 3:35, 4:16 using “charge accumulation period” and “integration time” interchangeably.

187. This description in Miyazaki of the sensors collecting and accumulating charge is consistent with the previous construction of “*integration time*” in the GM Litigation. Ex.1015, 49 (“the time the image sensor collects and integrates signal from the scene”).



Ex.1006, FIG. 2, annotated.

188. As exemplified below, a POSITA would have been motivated to

apply Miyazaki's teaching of using an on-sensor electronic shutter on a sensor to control the integration time of that sensor, for each sensor of Yu's multi-sensor multi-lens digital camera.

*controlling an electronic shutter
on each sensor to control an
integration time of that sensor*

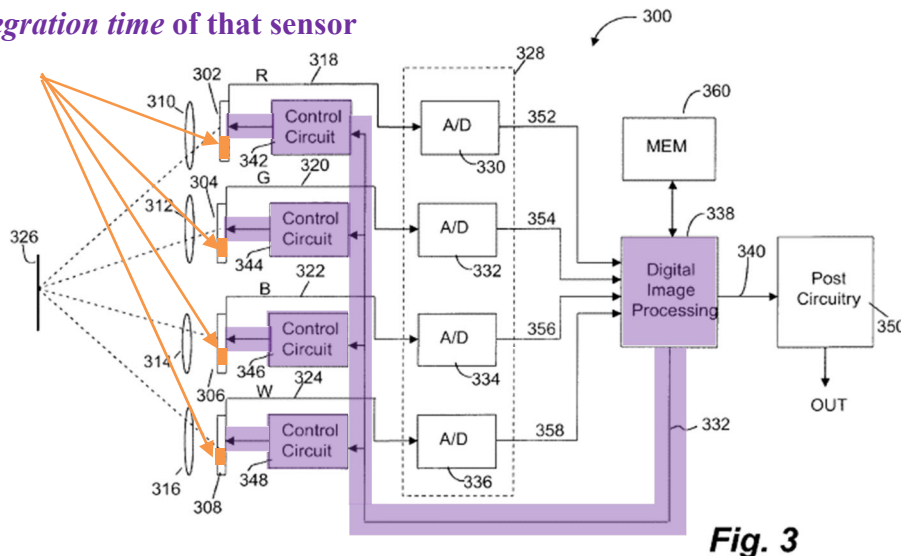


Fig. 3

*a processing component configured to control an
integration time of each sensor by controlling an
electronic shutter on that sensor*

Example Combination of Yu-Miyazaki (Ex.1005, FIG. 3, annotated).

189. Yu and Miyazaki are each analogous prior art to the '158 patent because they pertain to the same field of endeavor, namely, "[d]igital camera systems and methods." Ex.1001, 3:39-40; Ex.1005, Title ("Digital Cameras using Multiple Sensors with Multiple Lenses"); Ex.1006, Title ("Image Pickup Apparatus for Producing a Desired Frame of Image Signals").

190. Yu and Miyazaki are also analogous art to the '158 patent because they are each pertinent to a particular problem of the '158 patent, such as the

problem of controlling an exposure time/integration time of a sensor. Ex.1001, 1:32-34 (“The dynamic range of an image sensor can be increased by using multiple exposure times and/or integration times”); Ex.1005, 12:16-19 (“digital image processing circuitry produces four control signals, each controlling the exposure time of one of said four image sensors by analyzing respectively said four digital images”); Ex.1006, 4:16-19 (“the camera 10 controls a shutter speed, i.e., an exposure time at the time of a shot by controlling the mechanical shutter and an electronic shutter available with the CCD image sensor 14.”).

191. A POSITA would have been motivated to apply, in Yu’s digital camera, Miyazaki’s teaching of an on-sensor electronic shutter to provide the independent on-sensor control of exposure time for each image sensor (as described in Yu) and, accordingly, the integration time of each sensor in Yu’s digital camera, because doing so would provide the benefit of a fast, reliable, and small digital camera. Ex.1023, 11 (“Electronic exposure, which is much more accurate and reliable than mechanical shuttering, allows very versatile operation for systems or cameras.”). First, by using an on-sensor electronic shutter as taught by Miyazaki which allows a fast shutter speed, Yu-Miyazaki would capture fast-moving subjects with reduced blur. Ex.1010, 8 (“Electronic shuttering, also known as electronic exposure timing in photographic terms, is a standard feature [of an image sensor]....This feature can be especially useful in situations such as imaging

of fast moving objects where normal integration times [e.g., when using a mechanical shutter] cause smear, blurring, or image tear.”). Furthermore, using on-sensor electronic shutters as taught by Miyazaki allows for the elimination of any mechanical shutter in Yu-Miyazaki, which would allow for a more compact and lightweight camera due to the elimination of mechanical moving parts and the associated manufacturing and maintenance costs. Ex.1008, 2.

192. A POSITA would have been motivated to use an on-sensor electronic shutter to control an integration time of that sensor, as taught by Miyazaki, in Yu’s multi-sensor multi-lens digital camera. Yu describes a need to use an on-sensor exposure control to control an exposure time of each of its plurality of sensors. Ex.1005, FIG. 3, 12:16-19 (“digital image processing circuitry produces four control signals, **each controlling the exposure time of one of said four image sensors.**”). It was well-known that an electronic shutter is an on-sensor exposure control to control the exposure time (by controlling the integration time) of an image sensor. Ex.1008, 2-5 (describing on-sensor electronic shutters for CCD and CMOS imagers), Ex.1012, 2 (describing electronic shuttering as “a standard feature of virtually all consumer and most industrial CCDs”); Ex.1016, 1 (an image sensor by Texas Instruments providing “electronic shutter function”).

193. Yu does not describe the implementation details of its on-sensor exposure time control. Accordingly, a POSITA would have used, for each sensor

in Yu's multi-sensor multi-lens digital camera system, an on-sensor electronic shutter to control the exposure time by controlling the integration time of that sensor as taught by Miyazaki, (Ex.1006, 9:11-14), because electronic shutters were a standard feature in image sensors and provide the required function of Yu's on-sensor exposure time control. Ex.1010, 8. As I discussed at V.C above, Yu-Miyazaki, as well-known in the art, by using an electronic shutter that performs on-chip exposure time control, would allow the elimination of the mechanical shutter, thereby reducing the size and cost of the camera, and enabling much shorter (faster) integration times compared to a mechanical shutter. Ex.1008, 2 (Image sensors incorporating an on-chip electronic shutter "for controlling integration time...may allow the elimination of the mechanical shutter.").

194. Yu-Miyazaki would have been a combination of prior art elements (Yu's digital camera with independent control of the exposure time of each of the multiple image sensors with an electronic shutter of an image sensor configured to control the integration time, as taught by Miyazaki) according to known methods (controlling each electronic shutter of each image sensor to control the integration time of the sensor) to yield the predictable result of varying sensor integration time for exposure control.

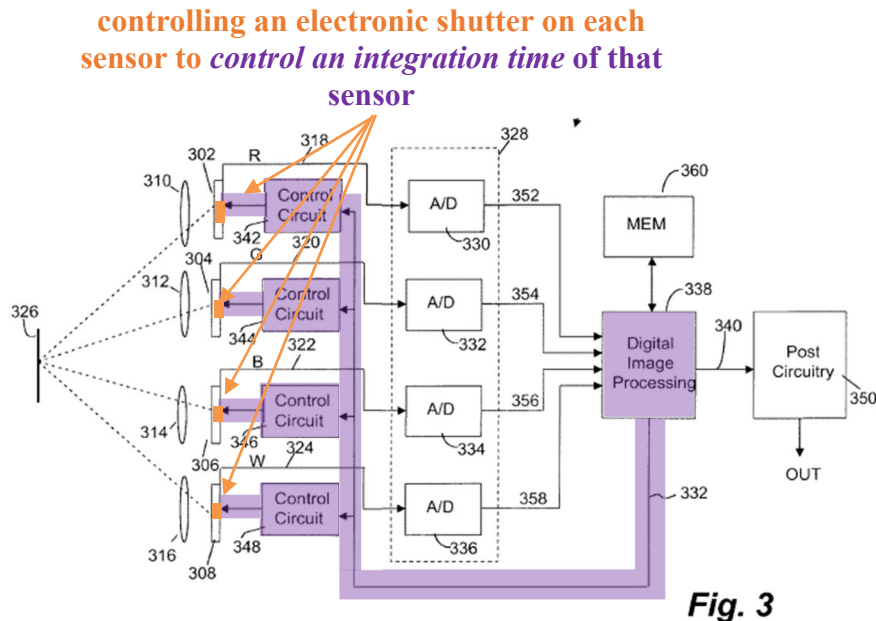
195. In addition, modifying Yu's multi-sensor multi-lens digital camera to implement, for each of the multiple sensors, controlling an on-sensor electronic

shutter to control the integration time of that sensor as taught by Miyazaki would be improving a similar device (Yu's multi-sensor multi-lens digital camera) in the same way. I understand there is a motivation to combine when a known technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the prior art elements according to their established functions.

196. A POSITA would have had a reasonable expectation of success in combining Yu with Miyazaki as presented above, because Yu-Miyazaki would have involved only routine knowledge well within the skill of a POSITA prior to the earliest priority date of the '158 patent. The digital cameras described in Yu and Miyazaki perform similar functions (using a control signal to control an image sensor) to achieve similar goals (controlling an exposure time of the image sensor) using similar technology. *See, e.g.,* Ex.1005, FIG. 3, 6:53-58 (“control circuits 342, 344, 346 and 348 receive respectively the control signals 332, each generated with respect to a corresponding histogram in digital image processing circuitry 338 and independently and respectively control image sensors 302,304,306 and 308); Ex.1006, 9:11-14 (“the controller 38 feeds an electronic shutter control signal to the CCD driver 36 for controlling the duration of charge storage in the CCD image sensor 14”).

197. A POSITA would have had a reasonable expectation of success in

combining Yu with Miyazaki, because as illustrated in the example Yu-Miyazaki combination below, it would have been within the ordinary skill of a POSITA to implement each of Yu's image sensors with an on-sensor electronic shutter for integration time control, as taught by Miyazaki.



a processing component configured to control an integration time of each sensor by controlling an electronic shutter on that sensor

Example Combination of Yu-Miyazaki (Ex.1005, FIG. 3, annotated).

198. As shown in the example combination above, it would have been within the ordinary skill of a POSITA to implement the teachings of Miyazaki in Yu's system. For example, implementing the electronic shutter mechanism based on design needs (e.g., CCD image sensor with electronic shutter, CMOS image sensor with a conventional rolling shutter, CMOS image sensor with a Kodak patented global shutter, CMOS imager provides both rolling shutter and global

shutter modes of operation) was well-known in the art. Ex.1008, 3-5 (describing different electronic shutter mechanisms).

199. As another example, it would have been within the ordinary skill of a POSITA implementing the electronic shutter control signal as taught by Miyazaki, using Yu's digital image processing unit 338 to provide independent control signals to control circuits 318, 320, 322, and 324. Using these independent electronic shutter control signals, (1) control circuit 318 is configured to control an electronic shutter on sensor 302, (2) control circuit 320 is configured to control an electronic shutter on sensor 304, (3) control circuit 322 is configured to control an electronic shutter on sensor 306, and (4) control circuit 324 is configured to control an electronic shutter on sensor 308, respectively.

200. Therefore, Yu-Miyazaki renders obvious *a processing component* (Yu's digital image processor 338, together with Yu's control circuits 342, 344, 346, 348) *configured to control* (using four independent feedback signals 332 and respective control circuits 342, 344, 346, 348, as taught by Yu) an *integration time* (integration time by controlling an electronic shutter of a sensor as taught by Miyazaki and applied in Yu) of *each sensor* (Yu's image sensors 302, 304, 306, 308).

201. Accordingly, Yu-Miyazaki renders obvious limitation [1.3].

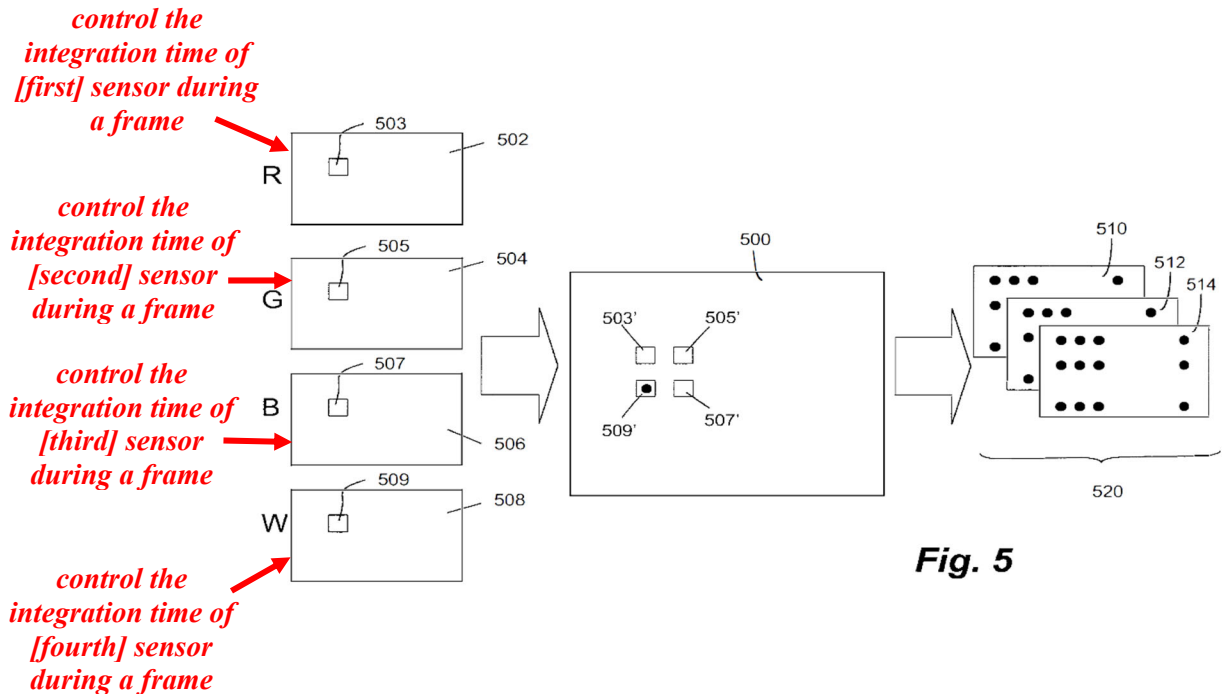
b) Claim 2

[2.0] *The device of claim 1, wherein the processing component is further configured to control the integration time of each sensor during a frame.*

202. Yu-Miyazaki renders obvious limitation [2.0].

203. First, as discussed at Ground 2:[1.3], Yu-Miyazaki renders obvious *wherein the processing component is configured to control the integration time of each sensor*. Specifically, Yu-Miyazaki renders obvious *a processing component* (Yu's digital image processor 338, together with Yu's control circuits 342, 344, 346, 348) *configured to control* (using four independent feedback signals 332 and respective control circuits 342, 344, 346, 348, as taught by Yu) an *integration time* (integration time by controlling an electronic shutter of a sensor as taught by Miyazaki and applied in Yu) of *each sensor* (Yu's image sensors 302, 304, 306, 308).

204. Second, as shown in annotated FIG. 5 of Yu below, in Yu-Miyazaki, *the processing component is configured to control the integration time of each sensor during a frame* (during a period of time in which data for a single image is captured by that sensor). VII.A (“*during a frame*” means “during a period of time in which data for a single frame of an image is captured” by a sensor);

**Fig. 5****Ex.1005, FIG. 5, annotated.**

205. Relative to FIG. 5, Yu illustrates “[f]our intensity images 502, 504, 506 and 508 [that] correspond respectively to four intensity images from four image sensors 302, 304, 306 and 308 of FIG. 3.” Ex.1005, 7:50-53. In Yu-Miyazaki, a *processing component* (Yu’s digital image processor 338, together with control circuits 342, 344, 346, 348) is *configured to control* (using four independent feedback signals 332 and respective control circuits 342, 344, 346, 348, as taught by Yu) an *integration time* (integration time by controlling an electronic shutter of a sensor as taught by Miyazaki and applied in Yu) of *each sensor* (Yu’s image sensors 302, 304, 306, 308) *during a frame* (i.e., during a period of time in which data for a single frame of an image) is captured by that

sensor. *see* VII.A (“*during a frame*” means “during a period of time in which data for a single frame of an image is captured” by a sensor); Ex.1006, FIG. 3, 8:4-20 (describing that intervals between successive shots are determines such that exposure time ST (charge accumulation time) for each shot is completed within a frame).

206. Specifically, in Yu-Miyazaki, the processing component is configured to control an integration time of image sensor 302 during a period of time in which data for a single frame of image 502 is captured by sensor 302, control an integration time of image sensor 304 during a period of time in which data for a single frame of image 504 is captured by sensor 304, control an integration time of image sensor 306 during a period of time in which data for a single frame of image 506 is captured by sensor 306, and control an integration time of image sensor 308 during a period of time in which data for a single frame of image 508 is captured by sensor 308.

207. Thus, Yu-Miyazaki renders obvious limitation [2.0].

c) Claim 4

[4.0] The device of claim 1, wherein each sensor is configured to image the same field of view.

208. Yu-Miyazaki, in view of a POSITA’s knowledge of optics design, renders obvious limitation [4.0].

209. Specifically, Yu itself teaches that the respective sensor and lens

pairings image “the **same imaging target**.” Ex.1005, FIG. 3, 9:66-10:1 (“With the configuration, each of the image sensors is respectively and independently controlled to expose to the same imaging target.”), 10:12-15 (“Further, with **images of the same imaging target from the multiple sensors**, it is possible to enhance images, such as noise removal and color correction at 820.”). As such, it was obvious that Yu, which is a multispectral imaging device, is configured to *image the same field view* (imaging the same imaging target), which was well-known in the art to be desirable in multispectral imaging, with the benefit of easy registration. Ex.1041, 2:12-16 (“Multispectral imaging is best accomplished when the images acquired by each channel’s image sensing device are identical in size. It is desirable that the image sensing pixels in each image channel see exactly the same geometric region in the field-of-view so that the images are exactly registered.”); Ex.1005, 4:66-67 (describing that its digital camera 300 “uses four **identical** image sensors 302, [3]04, 306, and 308”). It would have been obvious to use identical lenses with the identical sensors to achieve the same field of view in Yu.

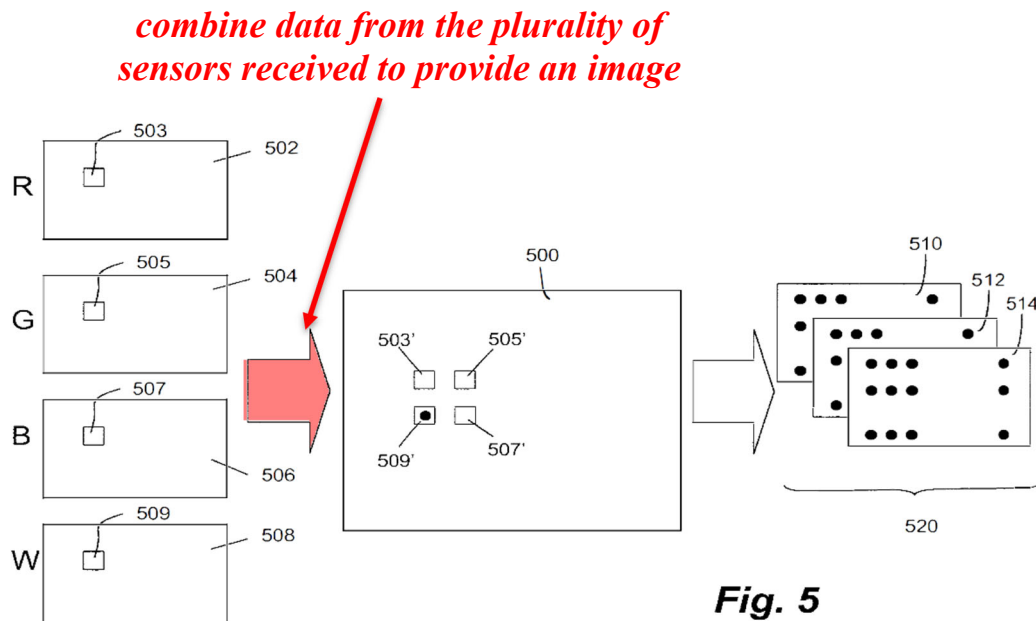
210. Accordingly, Yu-Miyazaki in view of a POSITA’s knowledge of optics design renders obvious use four *identical* image sensors 302, 304, 306, and 308, and four corresponding *identical* lenses 310, 312, 314, and 316 oriented to image the *same* target or scene, and as such, providing the same FOV.

d) Claim 5

[5.0] *The device of claim 1, wherein the processing component is further configured to combine data from the plurality of sensors received to provide an image.*

211. Yu-Miyazaki renders obvious limitation [5.0].

212. Specially, as shown in FIG. 5, Yu teaches that *the processing component* (Yu's digital image processing circuitry 338, together with control circuits 342, 344, 346, and 348) is *configured to combine data* ("combining four intensity images 502, 504, 506 and 508," as taught by Yu) *from the plurality of sensors received* ("[f]our intensity images 502, 504, 506 and 508 correspond[ing] respectively to four intensity images from four image sensors 302, 304, 306 and 308 of FIG. 3," as taught by Yu) *to provide an image* (virtual color image 500 and/or color image 520). Ex.1005, 7:46-59 ("a virtual color image 500 formed by combining four intensity images 502, 504, 506 and 508"); see also *id.*, 10:54-58 ("a digital image processor...producing a resultant digital image from said first digital image enhanced with said second digital image"); 11:7-9 ("said digital image processor increases the dynamic range of said first digital image by incorporating a portion of said second digital image into said first digital image"); 11:39-41 ("a digital image processing circuitry...producing a color image of said imaging target from said four digital images").



Ex.1005, FIG. 5, annotated.

213. Thus, Yu-Miyazaki renders obvious this limitation.

e) **Claim 8**

[8.0] *The device of claim 1, wherein the integration time is controlled based on incident light level.*

214. Yu-Miyazaki renders obvious limitation [8.0].

215. First, as discussed at Ground 2:[1.3], Yu-Miyazaki renders obvious *a processing component configured to control an integration time of each sensor.*

216. Second, Yu describes that the exposure time of each sensor is controlled *based on incident light level* (by analyzing a histogram presenting the pixel intensity distribution associated with incident light level). Ex.1005, 6:44-52 (describing determining the control signal from a histogram of the given image). In particular, Yu describes using a histogram to analyze incident light level and over-

saturation/under-saturation of the sensor in response to the incident light level of that sensor. Ex.1005, 6:44-52 (“Given an intensity image, there are many ways to determine if the given image is saturated due to an overexposure [to the incident light level on the sensor]. One of the available ways is to determine from a histogram of the given image....Large population concentrated on the high end of the histogram is an indication of saturation [caused by the current incident light level]. *Thus a control signal to reduce a predefined exposure time can be generated.*”); Ex.1005, 6:53-58 (“control circuits 342, 344, 346 and 348 receive respectively the *control signals 332*, each generated with *respect to a corresponding histogram* in digital image processing circuitry 338 and independently and respectively control image sensors 302, 304, 306 and 308.”); *see also* Ex.1006, 4:20-35 (“The CCD image sensor, or bidimensional image sensor, 14 has photosensitive devices....The photosensitive devices each generate a signal charge corresponding to a *quantity of light incident thereto via the color filter.*”).

217. Accordingly, a POSITA would have been motivated to apply Yu’s teaching that the exposure time is controlled based on incident light in Yu-Miyazaki, such that in Yu-Miyazaki, the *processing component* (digital image processor 338, together with control circuits 342, 344, 346, 348) is *configured to control* (using four independent feedback signals 332 and respective control

circuits 342, 344, 346, 348) an *integration time* (integration time by controlling an electronic shutter of a sensor as taught by Miyazaki and applied in Yu) of *each sensor* (image sensors 302, 304, 306, 308) *based on incident light level* (e.g., using the histogram technique).

218. Thus, Yu-Miyazaki renders obvious limitation [8.0].

f) Claim 9

[9.0] A system comprising:

219. Yu discloses or at least renders obvious the preamble, because Yu discloses *a system* (a digital camera system) as discussed above at Ground 2:[1.0].

[9.1] a plurality of channels, wherein each channel of the plurality of channels includes a sensor; and

220. Yu discloses or at least renders obvious limitation [9.1].

221. Consistent with Ground 2:[1.1] and [1.2], above, and as further illustrated in FIG. 3 below, Yu discloses *a plurality channels* (e.g., four channels), where a first channel includes lens 310 passing light to sensor 302, a second channel includes lens 312 passing light to sensor 304, a third channel includes lens 314 passing light to sensor 306, and a fourth channel includes lens 316 passing light to sensor 308. Ex.1005, 10:63-66 (“one of said two lenses is configured to allow said first image sensor sensitive to a selected range of said full region of visible color spectrum, and the other one of said two lenses is configured to allow said second image sensors sensitive to said full region of visible color spectrum”).

Further, Yu teaches *a plurality of channels* under the construction in the Toyota IPR as discussed at VII, because Yu's plurality of channels each include an independent optics component (lenses 310, 312, 314, and 316, respectively) that separately passes light to a different respective sensor.

a plurality of channels, wherein each channel of the plurality of channels includes [an independent optics component separately passing light to] a sensor

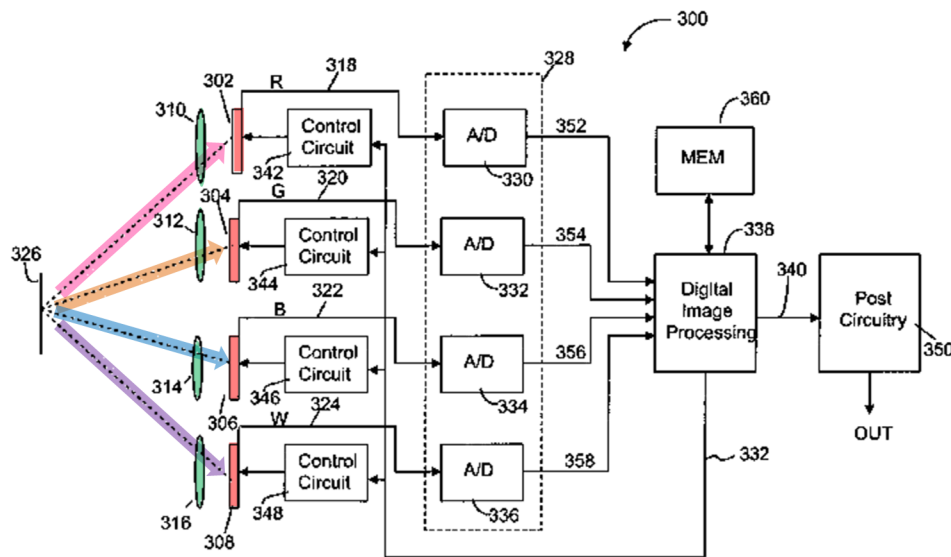


Fig. 3

Ex.1005, FIG. 3, annotated.

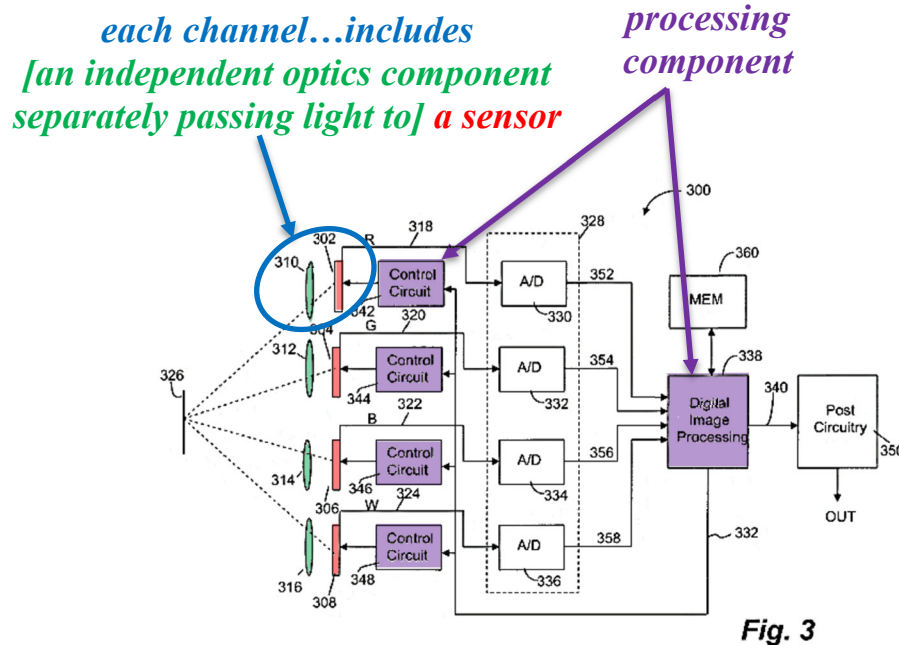
222. Thus, Yu discloses or at least renders obvious this limitation.

[9.2.1] a processing component coupled to the plurality of channels,

223. Yu discloses or at least renders obvious limitation [9.2.1].

224. Consistent with Ground 2:[1.3], above, and as further illustrated in FIG. 3 below, Yu discloses *a processing component* (digital image processing unit 338 with control circuits 342, 344, 346, and 348) coupled to *the plurality of*

channels (e.g., to the respective sensor 302, 304, 306, or 308, thereof).



Ex.1005, FIG. 3, annotated.

225. Thus, Yu discloses this limitation.

[9.2.2] wherein the processing component is configured to determine an integration time of each channel of the plurality of channels,

226. Yu-Miyazaki renders obvious limitation [9.2.2].

227. Consistent with Ground 2:[1.3], [8.0], and [9.1], Yu-Miyazaki renders obvious that *processing component* (digital image processing circuitry 338, together with control circuits 342, 344, 346, and 348) is configured to determine an integration time (an exposure time of the sensor) of each channel (e.g., of the respective sensor thereof). Consistent with Ground 2:[8.0], the integration time of each such sensor (and, accordingly, for the corresponding channel) is determined based on the incident light level for that sensor (and channel) as represented by a

histogram. Ex.1005, 6:44-52.

228. Thus, Yu-Miyazaki renders obvious this limitation.

[9.2.3] wherein the processing component is configured to combine data from the plurality of channels received to provide an image.

229. Yu-Miyazaki renders obvious limitation [9.2.3].

230. First, as discussed at Ground 2:[9.1] and [9.2.1], Yu discloses or at least renders obvious the plurality of channels, wherein each channel of the plurality of channels includes a sensor, and the processing component coupled to the plurality of channels.

231. Second, as discussed at Ground 2:[5.0], Yu-Miyazaki renders obvious that the processing component is further configured to combine data from the plurality of sensors received to provide an image.

232. Accordingly, Yu-Miyazaki discloses or at least renders obvious limitation [9.2.3], because in Yu-Miyazaki, the processing component is further configured to combine data from the plurality of channels received (from the plurality of sensors of the plurality of channels) to provide an image. Ex.1005, FIG. 5, 7:46-59; 10:54-58; 11:7-9; 11:39-41.

g) Claim 10

[10.0] The system of claim 9, wherein each sensor in the plurality of channels is configured to image the same field of view.

233. Yu-Miyazaki renders obvious limitation [10.0] for the reasons

presented above at Ground 2:[4.0].

h) Claim 11

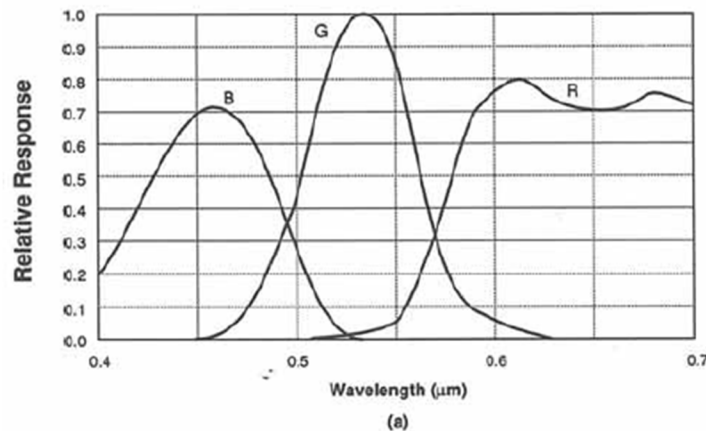
[11.0] *The system of claim 9, wherein the integration time of at least one channel is relatively shorter than the integration time of at least one other channel.*

234. Yu-Miyazaki renders obvious limitation [11.0].

235. First, consistent with Ground 2:[1.3] and [8.0], in Yu-Miyazaki, *the integration time* (exposure time controlled using electronic shutter) of each channel (e.g., the sensor thereof) is independently and respectively controlled based on incident light level (by analyzing a histogram presenting the pixel intensity distribution associated with incident light level) received at each such channel's sensor. Ex.1005, 6:44-52.

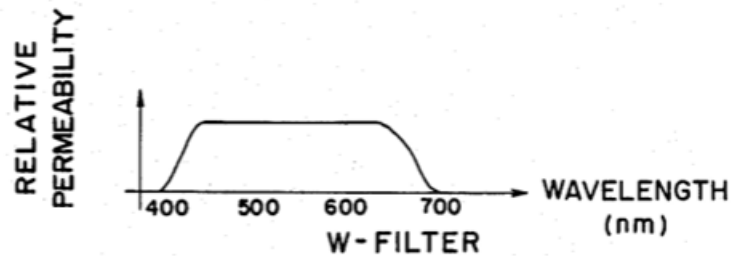
236. Second, Yu describes, “[a]ccording to another embodiment in which the W sensor is not used, three images from three color sensors can compliment each other in the same way as described. This can be done as a result of three images from three independent sensors, *each being separately controlled with different exposure time* and other system parameters.” Ex.1005, 9:40-46. A POSITA would have understood that Yu’s description of controlling the channels with different exposure times similarly applies to Yu’s FIG. 3 embodiment including four sensors, because the benefits of expanding the dynamic range by combining the captured images with different exposure times similarly applies Yu’s FIG. 3 embodiment.

237. Moreover, differences in separately controlled exposure/integrations times directly follow from Yu's teaching of incident light levels (*see* discussion at Ground 2:[8.0]) coupled with a POSITA's understanding that different portions of the visible electromagnetic spectrum are incident on pixel sites of red, green, blue and white light sensors (illustrated in spectral responses curves "R," "G," and "B" of Ex.1035, Figure 3-43(a) below).



Ex.1035, FIG. 3-43(a).

238. Further, as shown in Fig. 3a of Nagano below, white sensor pixel sites would be expected to receive a higher level of incident light of than those of the red (R), green (G) or blue (B) sensors that each receive only a portion of the larger spectral range of the white (W) sensor. Ex.1035, Fig. 3a; 3:59-65 ("The graph of FIG. 3a represents a white filter (W-filter) which permits the lights in the visible region to pass therethrough.").

Fig. 3a**Ex.1038, FIG. 3.**

239. Stated differently, the W channel will receive more light and thus have a shorter integration time than the R, G and B channels in Yu. *Id.* Moreover, because sensitivity of imaging sensors is dependent on wavelength, Yu's R, G and B channels will have different exposure/integrations times even for a spectrally balanced scene. Ex.1009, 4 ("The number of electrons collected at each pixel is linearly dependent on light level and exposure time and **non-linearly dependent on wavelength**").

240. Accordingly, in Yu-Miyazaki, it would have been obvious to make the integration times of the four channels different, which renders obvious that *the integration time of at least one channel* (e.g., a shorter exposure time for a first channel) *is relatively shorter than the integration time of at least one other channel* (e.g., a longer exposure time for a second channel).

241. Thus, Yu-Miyazaki renders obvious limitation [11.0].

i) Claim 13

[13.0] *The system of claim 9, wherein the processing component is configured to automatically control the integration time of each sensor.*

242. Yu-Miyazaki renders obvious limitation [13.0].

243. First, as discussed at Ground 2:[1.3] and [8.0], in Yu-Miyazaki, *the processing component* (digital image processing circuitry 338, together with control circuits 342, 344, 346, and 348) *is configured to control the integration time* (exposure time/integration time/charge accumulation time controlled using electronic shutters of image sensors) *of each sensor* (image sensors 302, 304, 306 and 308).

244. Second, Yu describes generating “four control signals, each controlling the exposure time of one of said four image sensors by analyzing respectively said four digital images,” specifically, from histogram analysis of the images. Ex.1005, 12:15-23. Because Yu’s exposure time control signals are generated from histogram analysis without human intervention, Yu describes automatically control the exposure time of each sensor.

245. Third, Miyazaki describes that the processing component is configured to automatically control the integration time of each sensor, by providing the “*automatic exposure adjusting function.*” Ex.1006, 5:56-60 (“the system controller 38 feeds a control signal indicative of an electronic shutter speed to be assigned to the CCD image sensor 14 to the CCD driver 36. In this sense, the

system controller 38 has an *automatic* exposure adjusting function.”).

246. Accordingly, in Yu-Miyazaki, a POSITA would have been motivated to implement the automatic control of the integration time, as taught by Miyazaki, for the benefits of simplified process without relying upon user inputs and responsiveness to actual illumination intensity and spectral characteristics of a given scene.

247. Thus, Yu-Miyazaki renders obvious this limitation.

j) Claim 14

[14.0] The system of claim 9, wherein the integration time is used to control an amount of electrical charge placed on one or more storage devices associated with a sensor.

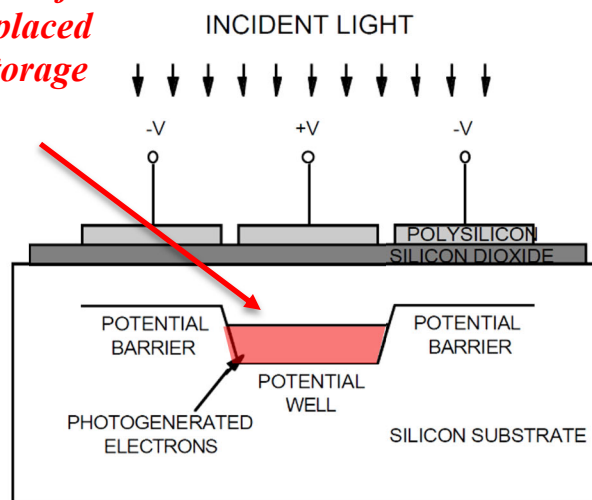
248. Yu-Miyazaki renders obvious limitation [14.0].

249. As discussed at Ground 2:[1.3], Miyazaki describes that “the [system] controller 38 feeds an electronic shutter control signal to the CCD driver 36 for **controlling the duration of charge storage** in the CCD image sensor 14.”

Ex.1006, 9:11-14; *see also id.*, 4:20-35 (“The CCD image sensor, or bidimensional image sensor, 14 has photosensitive devices.... The photosensitive devices each generate a signal charge **corresponding to a quantity of light incident** thereto via the color filter.”); Ex.1008, 2 (“In a CCD imager with a built in electronic shutter, the entire imager is reset before integration to remove any residual signal in the photodiodes. **The photodiodes then accumulate charge for some period of time.**”)

At the end of the integration period, all charges are simultaneously transferred to light shielded areas of the sensor.”); Ex.1012, 1-2; (“Both [CCD and CMOS] image sensors are pixelated metal oxide semiconductors. They accumulate signal charge in each pixel proportional to the local illumination intensity” and electronic shuttering was a well-known technique for controlling charge accumulation times of the charge storage devices of the sensors); Ex.1023, 4, 11 (“The number of electrons collected at each pixel is linearly dependent on light level and **exposure time** and non-linearly dependent on wavelength;” and “Electronic exposure, which is much more accurate and reliable than mechanical shuttering, allows very versatile operation for systems or cameras.”).

*control an amount of
electrical charge placed
on one or more storage
devices*

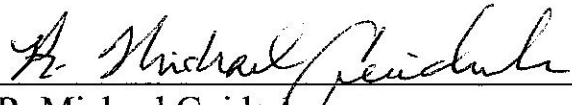


Ex.1022, 5, annotated.

250. Thus, Yu-Miyazaki renders obvious limitation [14.0].

IX. CONCLUSION

251. This declaration and my opinions herein are made to the best of my knowledge and understanding, and based on the material available to me, at the time of signing this declaration. I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 or Title 18 of the United States Code.

Date: 11/24/2024

R. Michael Guidash