UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ARASHI VISION (U.S.) LLC (D/B/A INSTA360),
Petitioner,

v.

GOPRO, INC.,
Patent Owner.

Patent No. 10,015,413

Inter Partes Review No. IPR2024-00984

DECLARATION OF DR. AGGELOS KATSAGGELOS

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I, Aggelos Katsaggelos, make this declaration in connection with the proceeding identified above.

I. INTRODUCTION

1. I have been retained by counsel for Arashi Vision (U.S.) LLC (d/b/a Insta360) ("Petitioner" or "Insta360") as a technical expert in connection with the proceeding identified above. I submit this declaration in support of Petitioner's Reply to Patent Owner's Response to Petition for *Inter Partes* Review of United States Patent No. 10,015,413 ("the '413 patent") (EX1001). I described my qualifications in detail in my opening declaration dated June 20, 2024, which I understand is Exhibit 1002 to this proceeding. (June 20, 2024, Katsaggelos Decl. (EX1002).)

2. I am being compensated at my standard consulting rate. I am also being reimbursed for expenses that I incur during my work. My compensation does not depend on the results of my study and analysis, the substance of my opinions, or the outcome of any proceeding involving the Challenged Claims. I have no personal or financial interest in the outcome of this matter or in any litigation involving the '413 patent.

3. I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify

competently thereto. I have been warned that willfully false statements (and the like) are punishable by fine or imprisonment, or both.

4. Although I am not a lawyer and will not provide any legal opinions, I have been advised to apply certain legal standards in forming my opinions. I set forth my understanding of some of those legal standards in my opening declaration. (EX1002, ¶¶27-31, 35, 36.)

5. I understand that Patent Owner and/or Dr. Foroosh have argued that the prior art does not teach certain limitations of the claims of the '413 patent. I offer the following opinions in response.

II. PROSECUTION HISTORY

6. Dr. Foroosh emphasizes the "determining a portion within the input image" limitation in his declaration and alleges that this step was added during prosecution to overcome the prior art that "merely disclosed an imaging containing such a portion after a transformation was complete." (EX2027, ¶59.) However, Dr. Foroosh improperly focuses on the "determining" aspect of the limitation—not the "within a portion" aspect. As I explained in my opening declaration, during prosecution, the Applicant argued that the cited art did not compare pixels ***within a portion*** of an image to other pixels in the ***same image***—instead, the cited art compared pixels of ***two images***. (EX1002, ¶24.) Thus, it is not the "determining"

aspect that distinguished over the art, but rather the "within a portion" of the same "input image" that distinguished over the art.

III. CLAIM CONSTRUCTION

7. I understand that Patent Owner did not explicitly propose any constructions of any terms of the '413 patent. However, it appears that Patent Owner and its expert, Dr. Foroosh, have interpreted certain claim terms to have meanings that differ from their ordinary and customary meanings.

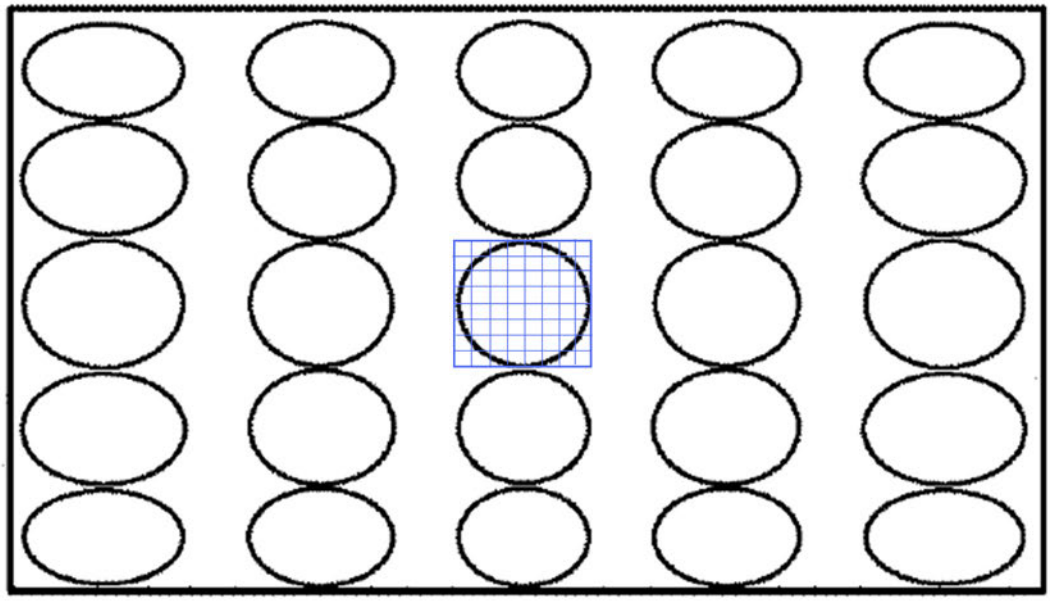
A. The '413 Claims Do Not Require A Non-linear Transformation Or That Each Pixel Be Shifted

8. Claims 1 and 2 of the '413 patent require "the transformation non-uniformly shift the pixels." Dr. Foroosh believes that the claims require a non-linear transformation, but I disagree. (EX2027, ¶68.) And I did not agree in my deposition that "non-uniform[] shifting" requires a non-linear transformation, or that the two terms have the same meaning. (EX2027, ¶68 (citing EX2026, 34:7-13).) Instead, my testimony that Dr. Foroosh cites was that "the application of a non-linear transformation results in the non-[uniform] shifting of the pixels." (EX2026, 34:7-13.) In other words, a non-linear transformation is a type of, but is not the same as, non-uniform shifting.

9. The embodiments of the '413 specification that Dr. Foroosh relies on to make his argument that "non-uniform" shifting requires a non-linear transformation are some, but not all, of the examples of non-uniform shifting.

(EX2027, ¶69 (citing EX1001, 1:12-18, 3:61-4:13).) This shows that "non-uniformly shifting" is not the same as a non-linear transformation. This is confirmed by Dr. Foroosh's argument that in an embodiment of the '413 patent, "non-uniform shifting" involves both a "non-linear warping process" and a "linear scaling function." (EX2027, ¶69.) If "non-uniform" means "non-linear," then non-uniform shifting would only involve a non-linear transformation. Because "non-uniform" involves more than just "non-linear," then "non-uniform" cannot mean "non-linear."

10. Dr. Foroosh argues that a non-linear transformation requires that "[n]o two pixels will have the same amount of shift." (EX2027, ¶75.) But the '413 specification discloses embodiments where two or more pixels have the same amount of shift. Figure 2B (below) is one example, where the pixels (blue) in the center portion containing the center circle have the same shift of zero. A POSITA would have understood that the center circle is made up of a plurality of pixels. The pixels of the center circle do not shift at all, *i.e.*, there are at least two pixels that have the same amount of shift. Further, the equations that Dr. Foroosh relies on to support his arguments are just "example equations. They're not restricting saying that these are the only equations that can be used," as he testified. (EX1015, 40:6-8; *see also* 43:24-45-1.)



11. I understand that, with a few exceptions (that do not apply here), patent terms are to be given their ordinary and customary meaning. The ordinary and customary meaning of "non-uniform" is "not the same in ***all*** parts or areas." (EX1016 (emphasis added).) In other words, two pixels having different shift would mean they do not have the same shift in all parts or areas or the image, thereby being "non-uniform." "non-uniform" does not require that "[n]o two pixels will have the same amount of shift." Thus, in my opinion, "non-uniform" means two or more pixels having different shifts.

B. The '413 Claims Do Not Require That The "determin[ing] a portion within the input image" (1[e] And 2[c]) Limitation Be After The "obtain[ing] the[/an] input image" (1[d] And 2[b]) Limitation

12. Claims 1 and 2 of the '413 patent do not require that the "determin[ing] a portion within the input image" step be performed after the image

is obtained. Claims 1 and 2 recite "obtain[ing] the[/an] input image" and "determin[ing] a portion within the input image" without reciting any terms that requires the steps be performed in a certain order.

13. The specification also describes embodiments where the "determin[ing] a portion within the input image" step is performed before the image is obtained. In the "vertical warp distortion" embodiment, applying a transformation that non-uniformly shifts the pixels uses ten pre-determined equations that are based on "the horizontal coordinate expressed as a percent of the total horizontal image size." (EX1001, 7:6-42.) In other words, pixels at the 0-10% horizontal coordinates are shifted using the first equation (7:14-15), pixels at the 10-20% horizontal coordinates are shifted using the second equation (7:17-18), pixels at the 20-30% horizontal coordinates are shifted using the third equation (7:20-21), pixels at the 30-40% horizontal coordinates are shifted using the fourth equation (7:22-23), pixels at the 40-50% horizontal coordinates are shifted using the fifth equation (7:25-26), pixels at the 50-60% horizontal coordinates are shifted using the sixth equation (7:27-28), pixels at the 60-70% horizontal coordinates are shifted using the seventh equation (7:30-31), pixels at the 70-80% horizontal coordinates are shifted using the eighth equation (7:33-34), pixels at the 80-90% horizontal coordinates are shifted using the ninth equation (7:35-36), and pixels at the 90-100% horizontal coordinates are shifted using the tenth equation (7:41-42).

The portions within the input image are determined based on the percentage of the horizontal coordinates. Because the equations are pre-determined equations, the portions within the input image are also pre-determined, *i.e.*, determined before the input image is obtained. And these pre-determined equations are based on a pixel's percentage of the horizontal coordinates, not the values of the horizontal coordinates. Being based on percentage means the portions may be determined without knowing the total horizontal coordinates of the input image—that is, the portions may be determined before obtaining the input image. I understand that Dr. Foroosh agrees that the equations could be applied to an input image regardless of the input size. (EX1015, 47:20-24.)

14. This shows that there are embodiments that "determine a portion within the input image" before the image is obtained. (EX2027, ¶62 (citing EX1001, 3:63-64, 4:19-22, 4:32-36).) The language of the claims does not require a certain order and does not exclude embodiments of the '413 specification, and as a result, a POSITA would have understood the '413 claims as not being limited to the embodiments that Dr. Foroosh points to and encompassing embodiments where the "determine" step is performed before the input image is obtained.

15. Dr. Foroosh argues that antecedent basis imposes an order. (EX2027, ¶59.) But I understand that antecedent basis is used in patent claims to make reference to the same element in a claim, not to impose a certain order. Thus, "the

input image" having antecedent basis to "an input image" of the '413 claims means that they are referring to the same "input image." Similarly, "the portion" having antecedent basis to "a portion" of the '413 claims means that they are referring to the same "portion."

IV. MEULEN AND CHAO

A. Meulen Teaches "apply[ing] a transformation to the input image" (Limitations 1[f] And 2[d]) Captured By An Image Sensor (Limitation 1[a]) And Obtained By "one or more [] processors [] included within a camera" (Claim 6)

16. The preamble of claim 1 and limitation 1[a] recite (in part) "[a]n image capture apparatus comprising: an image sensor configured to capture an input image." Limitation 1[d] requires "obtain[ing] the input image, and limitation 1[f] requires "apply[ing] a transformation to the input image." Thus, claim 1 requires applying a transformation to the input image captured by an image sensor.

17. Claim 2 recites a "system comprising: one or more physical processors configured by machine-readable instructions to: obtain an input image, . . . and apply a transformation to the input image." Claim 6 recites "[t]he system of claim 2, wherein the one or more physical processors are included within a camera." However, neither claim 2 nor claim 6 recites an "image sensor" or requires that the "input image" be captured from an image sensor of a camera, as Dr. Foroosh argues. (EX2027, ¶53.)

18. Further, claim 2 does not require that the "input image" be captured by the claimed "system." Although both claims 1 and 2 recites "obtain[ing] the input image." Claim 1 further requires "an image sensor configured to capture an input," whereas claim 2 does not include such recitation. And "obtain[ing]" has a different meaning than "captur[ing]." As a result, claim 2 does not require that the "input image" be captured from the claimed "system" of claim 2 or "camera" of claim 6.

1. Meulen obtains an input image by processors included within a camera

19. Meulen teaches "apply[ing] a transformation to the input image" by "one or more physical processors [] included within a camera." (EX1002, ¶¶249-250, 289-290.) Meulen discloses that its wireless device 100 comprises "one or more processors [or] controllers." (EX1007, 4:55-61.) Figure 5 (below) shows a block diagram of its wireless device 100 comprising a processor 510 and a display controller 504. Thus, its "one or more physical processors are included within a camera," as required by claim 6 of the '413 patent.

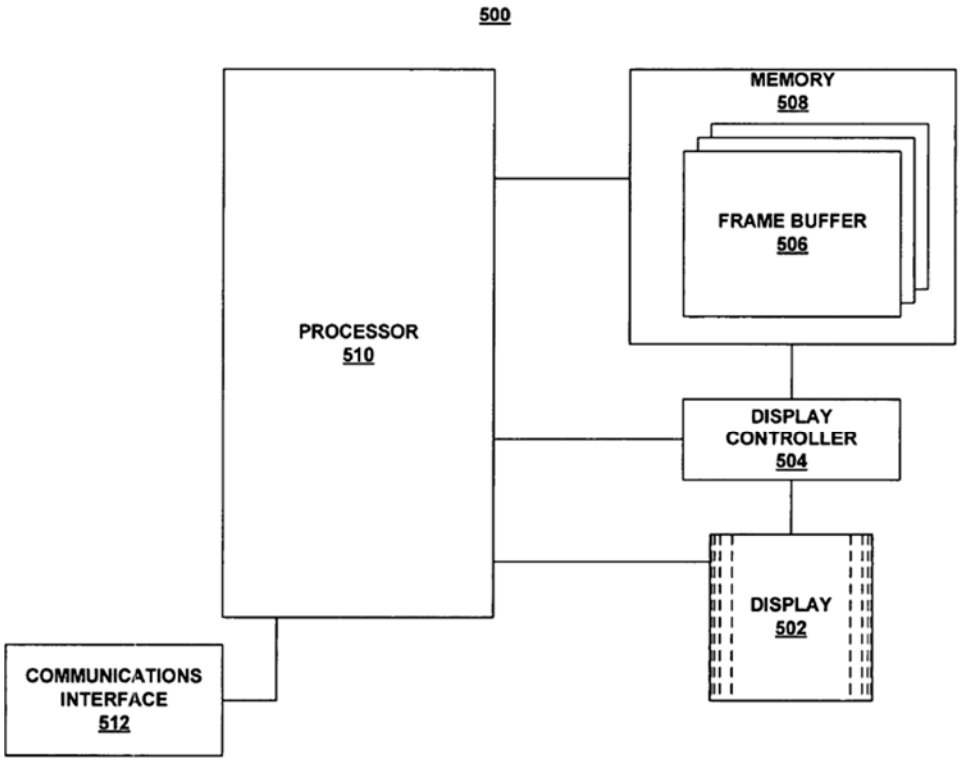


FIG. 5

20. Meulen discloses "the processor 510 may be arranged to run an operating system (OS) and various mobile applications" such as "a camera (e.g., digital camera, video camera) application." (EX1007, 12:62-13:4; EX1002, ¶¶289-290.) A POSITA would have understood a camera application on a wireless device to be an application that allows capturing an input image and viewing/modifying the image captured by the built-in camera of the wireless device. In other words, its processor 510 is a processor included within a camera that applies a transformation to the input image captured by the built-in camera. Dr. Foroosh agreed that camera applications allowed the user to view the image. (EX1015, 93:25-94:21.)

21. Meulen also discloses a display controller 504 (shown in Figure 5 above). (EX1002, ¶¶249-250.) "[T]he wireless device 100 may comprise display control software implemented by one or more applications, drivers, programs, modules, subroutines, instruction sets, instructions, computing codes, or a combination thereof." (EX1007, 4:62-66.) Meulen explains that its display controller 504 (included within its device) applies a transformation: "the display controller 504 may be arranged to apply image compression and/or scaling to the media source content stored in the frame buffer 506." (EX1007, 11:66-12:1.)

22. Thus, Meulen teaches "apply[ing] a transformation to the input image" by "one or more [] processors [] included within a camera."

2. Meulen's media sources include internal media sources

23. Meulen discloses an "image capture apparatus" and a "media source content," which Dr. Foroosh does not dispute is an "input image." (EX2027, ¶54.) Dr. Foroosh argues that Meulen's media source content is not captured by its built-in camera or image sensor, but instead comes from an external source only. (EX2027, ¶¶54-55.) But Meulen describes embodiments where the "media source content" may be from an internal source such as a built-in camera having an image sensor. This is consistent with the term "media source," which a POSITA would have understood as meaning a source of media. An internal source is a source of

media, including "any source capable of delivering media source content to the wireless device 100." (EX1007, 3:51-53.)

24. External media source: Meulen discloses receiving media source content from an external media source through a communications interface 512. (EX1007, 13:5-29.) Although I testified that the communications interface 512 is "an interface where you connect the processor to an input" (EX2026, 18:8-16), I did not testify that the communications interface 512 is the only source of media source content, or that the media source in Meulen is limited to an external media source. (EX2027, ¶56 (citing EX2026, 18:8-16).)

25. Internal media source: Meulen also describes internal media sources. It discloses embodiments where the "media source content [is] stored in the frame buffer 506. For example, the display controller 504 may be arranged to retrieve and process a line of source pixels from the display buffer 506 to generate a compressed and/or scaled line of display pixels." (EX1007, 11:66-12:5; *see also* 11:44-52 ("the frame buffer 506 may be arranged to store media source content.").) Figure 5 (below) shows the ***frame buffer 506***, which is not directly connected to the ***communications interface 512***. Patent Owner alleges that the communications interface 512 is the interface to the external media sources. (POR, 14.) Because the frame buffer 506 is not directly connected to the communications interface 512 (which Dr. Foroosh alleges is the interface to the external media source (EX2027,

¶57)), a POSITA would have understood that frame buffer 506 stores content from other sources such as internal media sources; otherwise, frame buffer 506 would be directly connected to the communications interface 512.

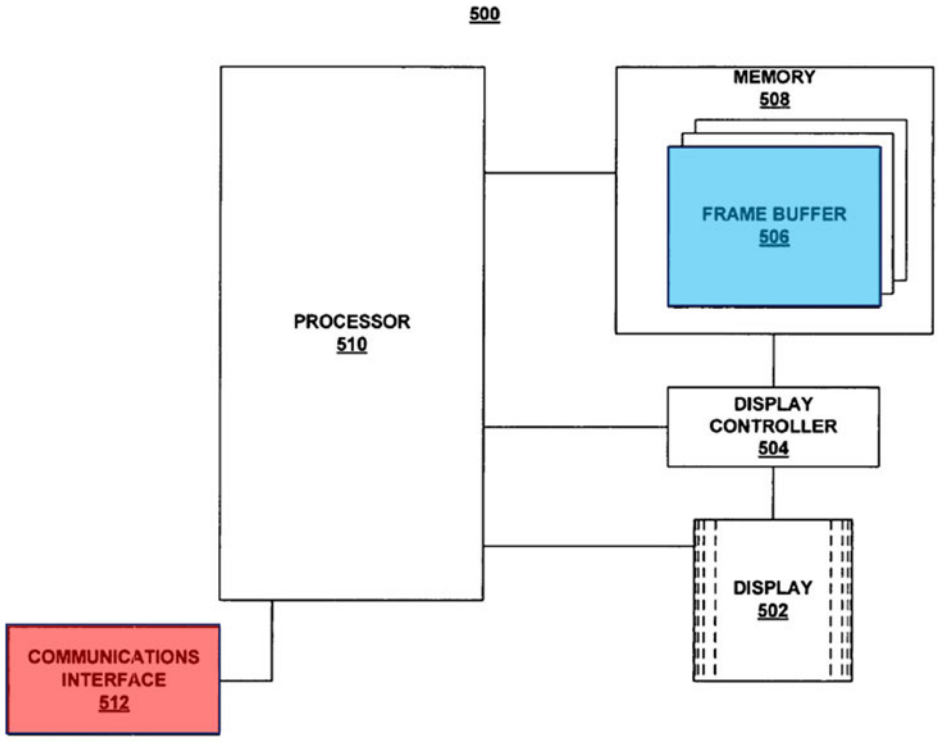


FIG. 5

26. The display controller 504 processes the media source content from the frame buffer 506, and its built-in digital camera is an internal media source that provides media source content to be stored in the frame buffer 506. (EX1007, 11:66-12:5, Fig. 5, 3:62-67). Thus, Dr. Foroosh is incorrect; Meulen teaches processing (applying a transformation) the images captured by its built-in camera. (EX2027, ¶57.)

27. Meulen also discloses "[t]he media source may include a device arranged to deliver pre-recorded media content stored in various formats. . . ." (EX1007, 3:62-64.) And then provides examples that include internal media sources "such as . . . a digital camera, video camera, a portable media player, a gaming device, and so forth." (EX1007, 3:64-67.) A POSITA would have understood that "a digital camera, video camera, a portable media player, [and] a gaming device" are internal media sources because its wireless device 100 runs mobile applications for operating these internal components. These mobile applications include applications for "a camera (e.g., digital camera video camera), . . . a multimedia player application, [and] a gaming application." Meulen also lists "a messaging application (e.g., e-mail, short message, multimedia)" and "a viewer application." (EX1007, 2:32-35, 3:14.)

28. I disagree with Dr. Foroosh that the media sources listed in 3:53-67 (including "computer" and "digital camera") are all examples of external media sources. (EX2027, ¶55.) Meulen discloses that its "wireless device such as a handheld ***computer*** and/or mobile telephone may incorporate features such as . . . a ***digital camera***." (EX1007, 1:6-9 (emphases added).) Hence, Meulen's wireless device comprises internal media sources: at least a computer and a digital camera.

29. Dr. Foroosh argues that Meulen's "media source" is an external media source only because Meulen describes the source as being capable of "delivering"

media source content to the wireless device 100. (EX2027, ¶55 (citing EX1007, 3:51-53).) This argument assumes that "deliver[ing]" may only come from a source external from the wireless device. However, the term "deliver" means to "send, provide or make accessible to someone electronically." (EX1017, 2c.) Thus, Meulen's statement simply states that the media source is any source capable of providing media source content to the wireless device 100, including a built-in camera providing the media source content to the wireless device 100.

3. Meulen applies non-uniform shifting to images captured by its built-in camera

30. Meulen discloses its wireless device 100 as applying non-uniform shifting to the images captured by its built-in camera. It explains that "display controller 504" is a processor that "may be arranged to apply image compression and/or scaling to the media source content stored in the frame buffer 506." (EX1007, 4:55-60, 11:66-12:5, 12:66-13:1.)

31. It would have been obvious for Meulen's wireless device 100 to have the capability to view the images captured by its built-in camera. Viewing images using a display (display 138 of Meulen) on the same device (wireless device 100) that captures images by its built-in camera was a known feature of wireless devices at the time of the '413 patent. For example, Meulen discloses that its "wireless device 100 may be implemented as a combination handheld computer and mobile telephone or smartphone." (EX1007, 2:9-11.)

32. Then, Meulen names the Palm Treo smartphones as examples. (EX1007, 2:12.) The Palm Treo 600, Palm Treo 650, and Palm Treo 700w/700wx are Palm Treo smartphones that were available at the time of Meulen. Each had a display having a first aspect ratio and a built-in camera having an image sensor with a different aspect ratio, like Meulen's wireless device 100. The user manual for the Palm Treo 650 describes its display as displaying the image captured by its built-in camera (internal media source): "[y]our Treo comes with an easy-to-use built-in camera, which allows you to instantly take, view, and share pictures with friends and family." (EX1018, 63; EX1036.) The Palm Treo 650 has a camera application that allows "[b]oth stills and movies [to] be taken and organized into customized albums. Each album then can be viewed in the media application for further organizing, filtering with a number of criteria, and creating slide shows." (EX1019, 5; *see also* EX1020, EX1020, 92-96; EX1036.) The Palm Treo 650 also allows "Review Before Saving – approve each photo and video before saving" with "[c]ustomize[d] settings for your photo/video shoot." (EX1037.) And the Palm Treo 700w user manual states that the "Palm® Treo™ 700w smartphone comes with an easy-to-use, built-in, 1.3-megapixel camera . . . You can use the camera to take and view pictures and videos." (EX1021, 125.) Meulen teaches applying a transformation to the input image by a Palm Treo, and the Palm Treos include built-in cameras that capture the input image. Thus, Meulen teaches

"apply[ing] a transformation to the input image" captured by an image sensor of an image capture apparatus.

33. I disagree with Dr. Foroosh that a POSITA would not have been motivated to perform Meulen's non-uniform shifting by processors included within a camera because "non-linear transformations were expensive to design and implement, and required significant processing power to execute." (EX2027, ¶108.) Meulen teaches different implementations for reducing the computational resources for non-uniform shifting by the processors included within the device. "In some implementations, the panoramic display may employ software to perform the sample-rate conversion at the expense of more memory and processing power. When performed by software, the sample-rate conversion may be implemented in registers rather than random access memory (RAM) to minimize the number of accesses or taps and to reduce processing expense." (EX1007, 10:48-54.)

34. Meulen also teaches "perform[ing] image compression and/or scaling using one or more sample-rate converters implemented by hardware and/or software." (EX1007, 5:14-30.) "The embodiment illustrated by Table 1 may comprise, for example, sample-rate converter circuitry implemented by two symmetrically arranged programmable hardware-based sample-rate converters." (EX1007, 6:37-41.) "The embodiments, however, are not limited in this context.

For example, the embodiment illustrated by Table 1 may comprise software to perform sample-rate conversion." (EX1007, 6:46-49.)

35. And not all non-uniform transformations require math operations. One example involves a lookup table (LUT) that maps the output positions to the input positions. A LUT is simple to use and requires a small amount of computational resources. The LUT may be stored in memory and used to look up the output position corresponding to an input position for non-uniform shifting of the pixels. Thus, not all non-uniform transformations involve complex operations.

4. Meulen has a need for performing aspect ratio conversion

36. Dr. Foroosh's argument that there is no need in Meulen to perform any aspect ratio conversion because the aspect ratios of the media source content and display are not different is incorrect. (EX2027, ¶57.) Meulen describes its invention as being applied to "media source content . . . compris[ing] an aspect ratio and/or a resolution that differs from the aspect ratio and/or resolution of the display 138." (EX1007, 4:13-15.)

37. Meulen provides examples of aspect ratios of the media source content: "[m]ost media sources, however, have a non-square aspect ratio such as 4:3, 3:2, 16:9, or even 2:1. For example, . . . many digital video cameras use an aspect ratio of 16:9." (EX1007, 1:18-23.) It provides examples of aspect ratios of 1:1 and 3:2 for the display. (EX1007, 1:58-62, 4:15-34, 5:62-65, 6:64-67, 7:46-48,

8:12-15, 9:31-34, 11:7-11, 11:56-65.) And a POSITA would have understood that the aspect ratio of the input image (media source content) may not be the same as the aspect ratio of the image sensor. Thus, Meulen needs to perform aspect ratio conversion because the media source content (image from the built-in camera) has an aspect ratio that is different from the aspect ratio of the display 138. This is confirmed with the Palm Treo devices that Meulen applies its image compression and/or scaling to. (EX1007, 2:12.) The Palm Treo 600 and 650 each has a media source content aspect ratio of 4:3 (the aspect ratio of a VGA camera (640x480)) and a display aspect ratio of 1:1 (160X160 and 320x320 displays). (EX1022, 1; EX1023, 1-2; EX1035.) The Palm Treo 700wx has a media source content aspect ratio of 5:4 (1280x1024) and a display aspect ratio of 1:1 (240x240). (EX1024, 2.)

38. I also disagree with Dr. Foroosh's argument that Meulen used alternative techniques such as cropping, padding, or linear scaling. (EX2027, ¶58.) Meulen describes its invention as "a wireless device having a square or substantially square display may be arranged to emulate a non-square display and to better match the aspect ratio of typical video content ***without cropping***." (EX1007, 2:2-7 (emphasis added).) Further, Meulen states that its invention is an improvement over padding (i.e., not padding): "[c]onventional best fit algorithms . . . may be suitable for fitting content to non-square displays, but produce a black bar on square displays. Consequently, there may be a need for improved display

screens and techniques for a wireless device." (EX1007, 1:26-31.) Finally, Meulen teaches non-uniform shifting, ***not*** linear scaling.

39. In some instances, a POSITA would not have preferred cropping, padding, or linear scaling over non-uniform shifting. This is because cropping, padding, and linear scaling remove portions of the image, add black bars, or add noticeable distortion. I note that even the '413 patent acknowledges that these are "common problem[s] in the field of image and video processing." (EX1001, 1:6-7.) It states that "cropping removes content from the image and reduces the field of view of the image. Linear scaling . . . introduces perceivable distortion into the image. . . . Padding maintains the full field of view without distortion, but results in unused display space around the sides and/or top of the image, thus rendering an image that appears too small relative to the display." (EX1001, 1:14-25.) Dr. Foroosh agreed that "it's a problem. It was a problem back in 2013." (EX1015, 60:23-62:9.)

40. Here, the issue is whether a POSITA would have been motivated to perform non-uniform shifting (as taught by Meulen, Fleming, and Obara) for aspect ratio conversion. The issue is not whether a POSITA would have found cropping, linear scaling, or padding as "adequate for the type of preview screens embodied in digital cameras in 2013," as Dr. Foroosh alleges. (EX2027, ¶109.) In

some applications, a POSITA would have been motivated to perform non-uniform shifting.

B. Meulen Teaches "determin[ing] a portion within the input image" (Limitations 1[e] And 2[c])

41. There are multiple passages in Meulen that show that it "determine[s] a portion within the input image," including passages about dividing regions of the image and determining the regions based on user control.

42. Dividing regions. Meulen determines the regions of the image corresponding to a central region and lateral regions of the display. It discloses that "central display region 140-3 may comprise 200 pixels and require the media source content to undergo no image compression (e.g., 200 source pixels to 200 display pixels)." (EX1007, 6:27–31.) The "image compression and/or scaling may be applied to the media source content that is to be displayed in the lateral display regions. . . ." (EX1007, 6:4-6.) In order for the image compression and/or scaling to be applied correctly, the regions must be determined before applying the image compression and/or scaling. The regions are not determined as a result of the transformation, as Dr. Foroosh alleges (EX2027, ¶60), because the processor(s) would need to determine which portions of the media source content should be compressed/scaled with a certain compression/scaling ratio. Without determining the regions, the region of the image corresponding to the central display region may not "undergo no image compression," and the "image compression and/or

scaling may" not "be applied progressively." (EX1007, 6:4-8, 6:27-51.) Instead, the image compression and/or scaling may be applied randomly, for example.

43. Meulen's disclosures of embodiments having different numbers of regions also shows that it "determine[s] a portion." For example, the Table 1 embodiment has five regions, while the Table 2 and Table 3 embodiments each has nine regions. (EX1007, 5:50-6:13, 7:34-8:31.) Meulen discloses "the display 138 may comprise a plurality of display regions, such as regions 140-1-n, where n represents a positive integer value." (EX1007, 4:24-31.) Meulen's use of an integer value suggests that the number of display regions, and as a result, number of regions of the image, are not fixed. When the number of regions differs, the regions within the input image are different, thereby showing that the regions are determined. If Meulen did not perform a "detemin[ation]" step, then the number of regions would be fixed and the same. Since the number of regions differs, they are not pre-assigned; instead, Meulen determines the regions (portions). (EX2027, ¶¶64-65.)

44. Meulen's disclosures of different compression ratios also show "determin[ing] a portion." For example, different regions of the image are determined to have different compression ratios of 4:1, 2:1, and 0 for the Table 1 embodiment, 7:1, 4:1, 2:1, and 3:2 for the Table 2 embodiment, and 14:1, 8:1, 4:1, and 3:1 for the Table 3 embodiment. (EX1007, 5:50-60, 7:37-44, 8:1-10.) Meulen

discloses "the panoramic display 200 may be implemented as either low compression or high compression based on the number of pixels and/or image compression ratio used for the plurality of display regions 202-1-9." (EX1007, 7:30-33.) In other words, the portions and compression ratios are not pre-assigned, but instead are determined based on the number of pixels and/or image compression ratios in the regions of the image. (EX2027, ¶64.) The number of pixels and/or image compression ratios is determined before determining low compression or high compression since the compression is "based on" it. And the regions of the image need to be determined before determining the number of pixels and/or image compression ratios because the number of pixels and/or image compression ratios are based on the determined regions. Further, I note that whether the compression ratios are pre-assigned does not inform whether the regions of the image are pre-assigned.

45. Dr. Foroosh cites my deposition testimony in several paragraphs of his declaration which I think needs clarification. The testimony cited in ¶64 of Dr. Foroosh's declaration regarding pre-assigned compression ratios and Tables 1-4 is in regards to some, but not all, embodiments of Meulen. (EX2027, ¶64 (citing EX2026, 20:18-22, 23:3-6).) Regarding the testimony cited in ¶65 about the "designer's choice," I clarified in my deposition that "[b]y designer, I meant the person who implement[s] that, having all these choices, and these choices can

change based on the content. It is not a static choice that's done once, right? Depending on what content needs to be displayed, one has a choice -- many choices and has to pick one." (EX2026, 23:12-17; *see also* 23:21-24:3).) In other words, the portions and compression ratios are not necessarily decided in advance, as Dr. Foroosh alleges. (EX2027, ¶¶65, 67.) The portions may be determined after the input image is obtained, such as when the determination is made based on content or characteristics of the input image. (EX2026, 22:16-24:17.) The compression ratio for each portion needs also to be determined appropriately (they cannot be preassigned) so that the target dimensions (and aspect ratio) are met.

46. Dr. Foroosh also cites my testimony to allege that I believe that the "apply a transformation" limitation and "determine a portion within the input image" limitation involve a single step. (EX2027, ¶66 (citing EX2026, 28:15-23, 30:2-18, 30:24-31:8).) I think this testimony needs to be clarified. I did not testify that these two limitations involve a single step. Instead, I stated that "[the limitations] are just intertwined, these ***two*** steps." (EX2026, 31:7-8 (emphasis added).) Further, the questions that Patent Owner asked me during my deposition were ambiguous and not specific to the '413 claims (EX2026, 28:15-17 ("Q. Is it your opinion that the determination of the portion could be accomplished just by virtue of the nature of the transformation that's applied?").)

47. Determining regions based on user control. Meulen also discloses determining regions (portions) based on user control. "In some embodiments, for example, the center of linearity and/or center of compression for the panoramic display 200 may be shifted to the left and/or to the right under user-control (e.g., navigation button 122) to provide a shifted or magnified effect." (EX1007, 9:1-10:6.) It would have been obvious that providing a shifted or magnified effect refers to shifting or magnifying an object or focal point on the media source content, which would not be identified by the user until after the input image is obtained. Thus, the portion within the input image is determined based on user control after the input image is obtained. The input image is obtained, the user then provides user control to determine the portion within the input image followed by applying the transformation. This user control is like the user-selected mode of the '413 specification, which I understand Dr. Foroosh alleges is a "determin[ation]" after the input image is obtained. (EX2027, ¶63.)

48. Meulen's Figure 5 shows that it "determine[s] a portion within the input image" after "obtaining the input image." Meulen discloses the "frame buffer 506 may be arranged to store media source content." As shown in Figure 5 (below), the display controller 504 is located between the frame buffer 506 and the display 502. This means the media source content from the frame buffer 506 is

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delivered to the display controller 504 for applying the image compression and/or scaling before delivery to the display 502 (for viewing).

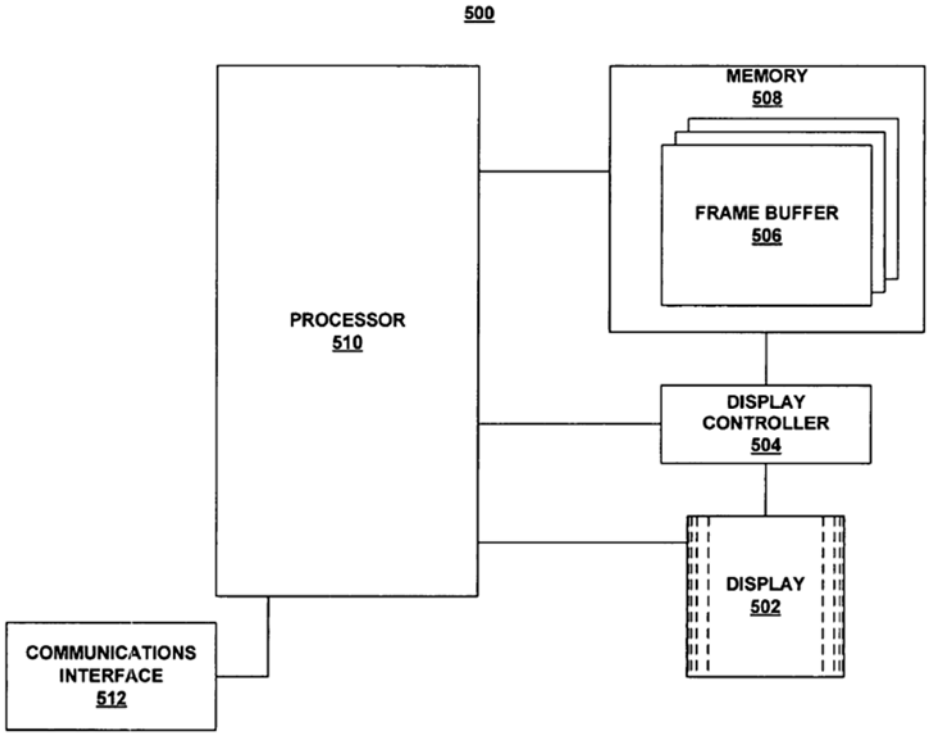


FIG. 5

49. Meulen discloses that the "display controller 504 may be arranged to expand one or more display regions. . . ." (EX1007, 12:23-25, *see also* claim 9.) This expansion of regions involves "determin[ing]" the regions, as performed by the display controller 504. Because the display controller expands the regions of the image, the regions are not predetermined. Since the display controller 504 is located between the frame buffer 506 and display 502, a POSITA would have understood that frame buffer 506 stores the image before being delivered to the display controller 504, i.e., obtain the input image before the display controller

determines the regions. (EX1007, Fig. 5.) As a result, Meulen teaches the display controller determining the regions after it obtains the image.

50. The display controller 504 then applies a transformation. (EX1007, 11:66-12:1 ("the display controller 504 may be arranged to apply image compression and/or scaling to the media source content stored in the frame buffer 506."). In some embodiments, the regions need to be determined beforehand so that the image compression and/or scaling that requires knowledge of the regions may be applied. For example, "apply[ing] image compression and/or scaling progressively to the media source content ***based on the proximity of a display region*** to the edge of the display 502" requires determining the regions in order to know the proximity of the display region. (EX1007, 12:9-12 (emphasis added).) Thus, Meulen teaches applying a transformation after and as a separate step from determining the regions.

C. Meulen Teaches "the transformation non-uniformly" Shifts The Pixels (Limitations 1[g] And 2[e])

51. Meulen teaches non-uniform shifting. A piecewise linear transformation is a type of non-uniform shifting that shifts the pixels not the same in all parts or areas. Meulen's piecewise transformation uses multiple transformations that have different shifts. For example, in the Table 1 embodiment (annotated below), the regions of the image corresponding to display regions 140-1 to 140-5 have compression ratios that are not the same in all parts or areas. The

compression ratio in the display regions 140-1 and 140-5 is 4:1, which is not the same as the compression ratio in the display regions 140-2 and 140-4 of 2:1. The compression ratio in the display region 140-3 is 0, which is not the same as the either the compression ratio of display regions 140-1 and 140-5 or the compression ratio of 140-2 and 140-4. Thus, Meulen's compression is not the same in all parts or areas of the image. Dr. Foroosh agreed. (EX1015, 99:5-15.) Because the shifts are not the same in all parts or areas of the image, i.e., "non-uniform" shifting, Meulen's piecewise linear transformation non-uniformly shifts the pixels. (EX2027, ¶¶70-71.)

TABLE 1

	Region					
	1	2	3	4	5	Total
Pixels/Region	10	50	200	50	10	320
Compression Ratio	4:1	2:1	none	2:1	4:1	
Source Pixels	40	100	200	100	40	480

52. Dr. Foroosh argues that a piecewise linear transformation is not a non-linear transformation because it does not perform a non-linear calculation. But the '413 patent claims do not require, a non-linear transformation, a non-linear calculation, a transformation involving a certain level of complexity, or that "no pixel is shifted in the same way," as Dr. Foroosh alleges. (EX2027, ¶72.) The

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’413 patent claims only require “non-uniform[] shift[ing].” Further, Dr. Foroosh focuses on each of the “multiple rectangles” to argue that the transformation is not non-linear. (EX2027, ¶71.) But he does not reach this conclusion based on the overall transformation of the entire image, which is a non-linear transformation.

53. Meulen also teaches non-uniform shifting that is not piecewise transformation, but instead “image compression and/or scaling . . . applied progressively. . . .” (EX1007, 10:32-33.) “In this embodiment, a panoramic display may be implemented by employing significantly more display regions (e.g., >30) and hardware-based sample-rate converters to ***smooth the visual transitions from one display region to another***.” (EX1007, 10:44-48 (emphasis added).) This progressive image compression and/or scaling is shown in Figures 4A-4C (below) (showing non-linear curves). The figures show that no two pixels in the regions of the image corresponding to the lateral display regions have the same amount of shift.

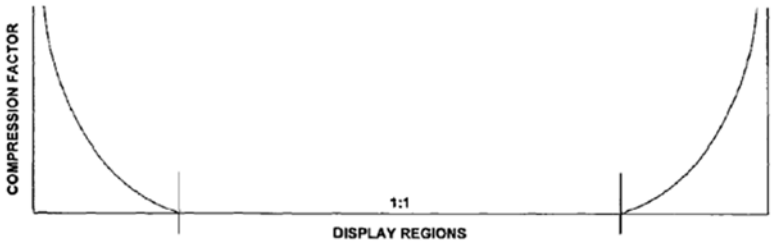


FIG. 4A

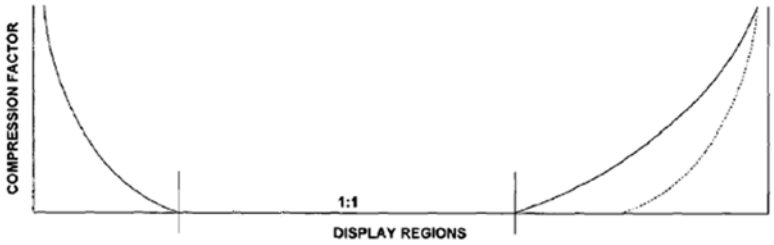


FIG. 4B

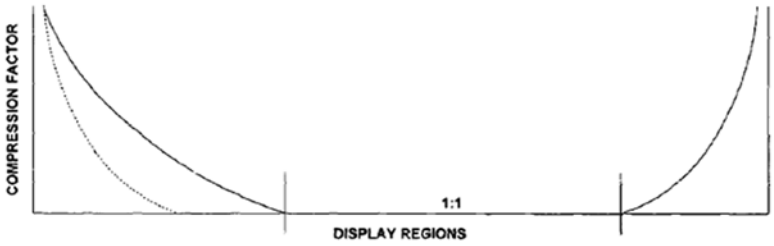


FIG. 4C

54. Dr. Foroosh cites my testimony and argues that piecewise transformations are computationally indistinguishable from linear transformations. (EX2027, ¶72 (citing EX2026, 40:19-41:8).) He also cites my testimony to argue that piecewise transformations are used to avoid the complexities of non-linear transformations. (EX2027, ¶73 (citing EX2026, 38:23-39:3, 40:1-7).) I note that when asked whether to "pursue the linear transformation over a non-linear [transformation]," I answered that "[i]t all depends." (EX2026, 40:19-41:8.) I explained that non-linear transformations ***may*** be complex depending on one or

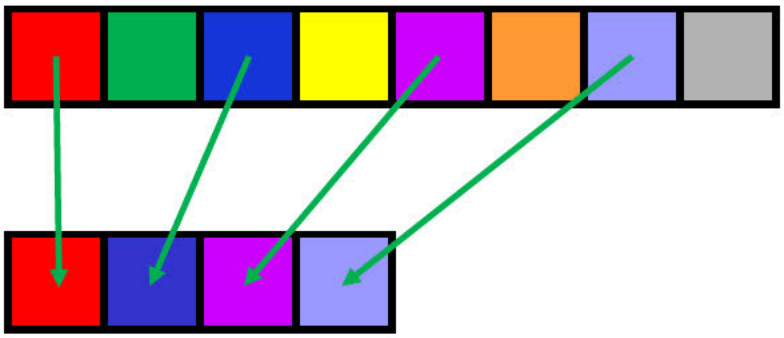
more factors such as the non-linear function or the number of regions. A POSITA would have understood that the complexity increases with an increase in the number of regions. Notably, Meulen discloses its wireless device having processor(s) that can perform a non-uniform shift using a large number "(e.g., > 30)" of regions. (EX1007, 10:44-47.)

55. Meulen also teaches different implementations for the processor(s) of its wireless device being able to reduce the complexity, even when there is an increase in the number of regions. "In some implementations, the panoramic display may employ software to perform the sample-rate conversion at the expense of more memory and processing power. When performed by software, the sample-rate conversion may be implemented in registers rather than random memory access (RAM) to minimize the number of accesses or taps to reduce processing expense." (EX1007, 10:48-54.) The memory and processing discussed in Meulen refer to the memory and processor included within its wireless device. Thus, Meulen teaches performing non-uniform shifting by the processor included within its wireless device including being able to perform complex non-uniform shifting involving a large number of regions.

D. Meulen Teaches "shift[ing] the pixels" (Limitations 1[g] And 2[e])

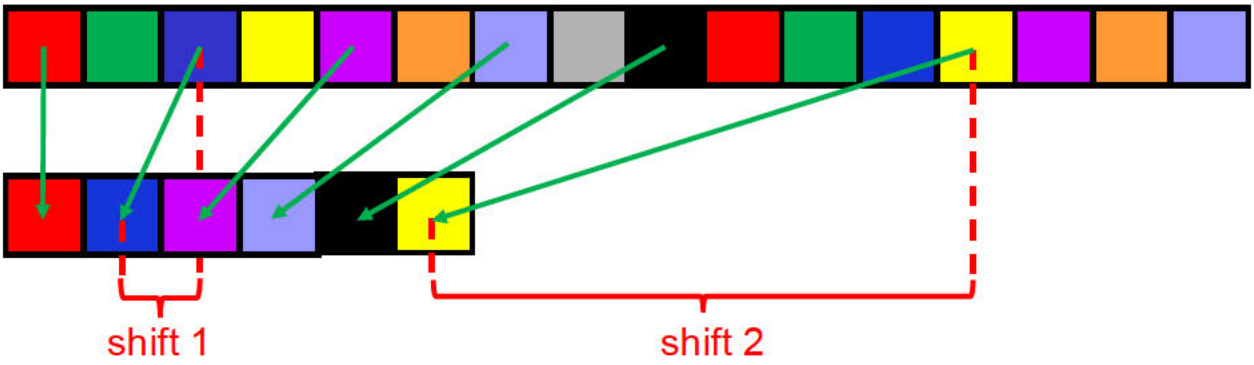
56. Meulen's wireless device 100 performs image compression and/or scaling for aspect ratio conversion. The compression may be performed using

sample-rate conversion. (EX2007, 5:15-29, 6:37-49.) Polyphase filters is one example type of sample-rate conversion. Sub-sampling is another type of sample-rate conversion, where a subset of the pixels of the input image are sampled. (EX1025.) For example, for a 2:1 compression, every other pixel may be sampled, which results in the position of every other pixel being shifted to a different position. This is shown in the figure below of a simplified example. The top part of the figure shows eight pixels of a row of an input image. Sample-rate conversion via sub-sampling with a 2:1 compression may sample every odd pixel to generate the output image having the pixels shown below. The center position of the sampled pixels shift, as shown by the green arrows.



57. When the compression changes to, e.g., 4:1, in another region (eight right pixels), then the sample-rate conversion with a 4:1 compression may sample every fourth pixel to generate the output image with the 9th (black) and 13th (yellow) pixels (shown on the right of the figure below). The center position of the sampled pixels shift, as shown by the green arrows. As the figure below shows, applying a 4:1 compression (eight right pixels) leads to a shift ("shift 2") that is

greater than the shift ("shift 1") for the 2:1 compression (eight left pixels)—i.e., non-uniform shifting. I note that even the shift is not same for pixels that have the same compression, *e.g.*,, the shift of the third pixel (blue) is different from the shift of the seventh pixel (purple), both pixels have a 2:1 compression.



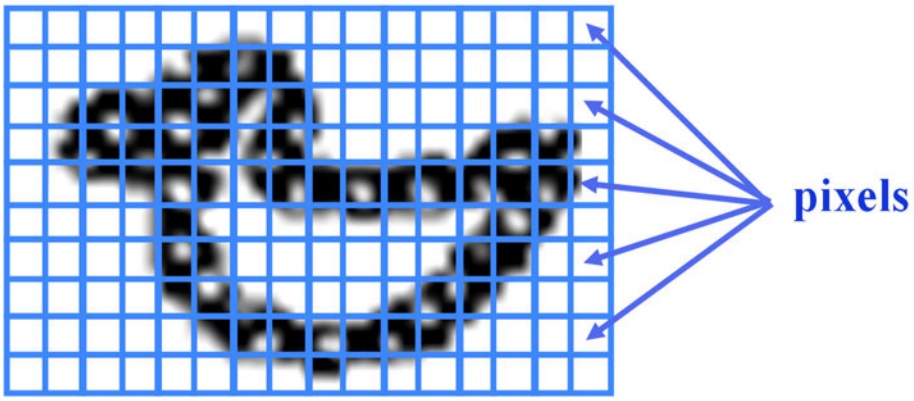
58. Dr. Foroosh acknowledges that Meulen teaches reducing the number of pixels by compressing or scaling "multiple 'source pixels' compressed into a smaller number of 'display pixels'." (EX2027, ¶80.) He also admits that pixel shifting may reduce the number of pixels in the image. (EX2027, ¶79.) Further, the '413 patent claims do not exclude embodiments where the number of pixels from the input image to the output image changes. Dr. Foroosh agreed. (EX1015, 35:8-23.)

59. And even the '413 patent uses the term "compression" when describing pixel shifting. (*See, e.g.*, EX1001, 4:9-13 ("[i]n the warping step 206, a non-linear warping is applied which results in the circles being stretched/compressed by different amounts depending on their horizontal and

vertical positions resulting in example image 216.").) Thus, Meulen's image compression and/or scaling non-uniformly shifts the pixels.

E. Chao Teaches "non-uniformly shift[ing] the pixels" (Limitations 1[g] And 2[e])

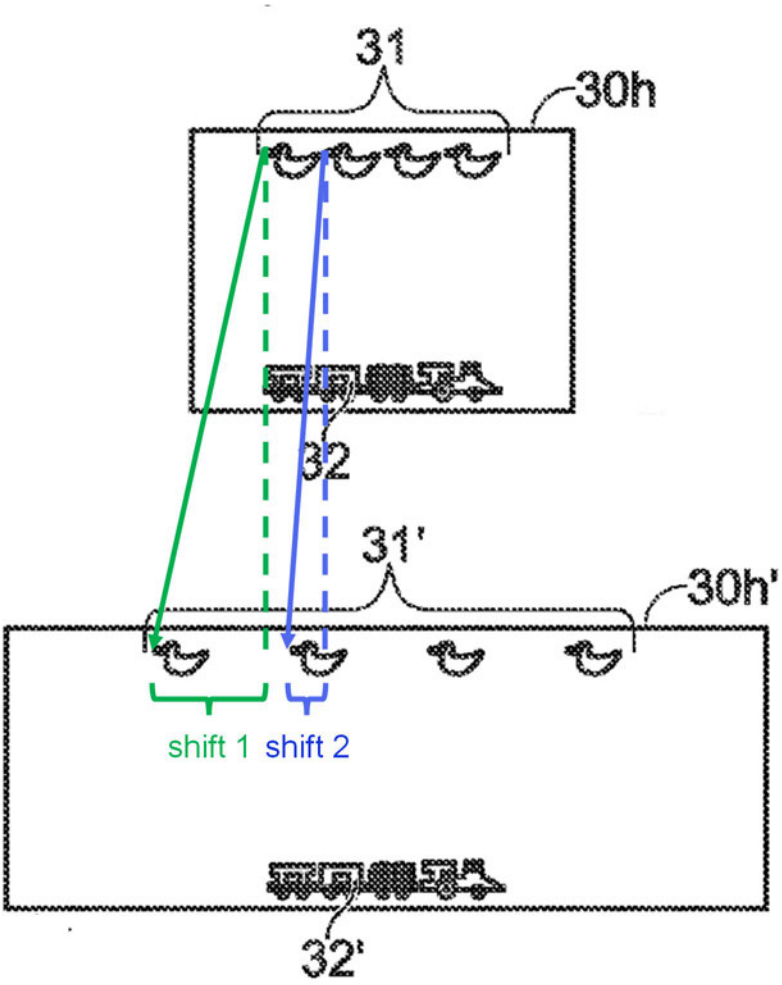
60. Dr. Foroosh admits that Chao discloses shifting, but argues that it shifts objects, not pixels. (EX2027, ¶83.) However, as shown in the example figure below, the image of an object is made up of pixels. As a result, shifting the object means shifting the pixels. A plurality of pixels collectively forms an image of a duck in the example below. To shift the duck would require shifting the pixels that form the duck. I note that although the figure below has 160 pixels, the object may be formed using a different number of pixels. Thus, Chao teaches shifting the pixels.



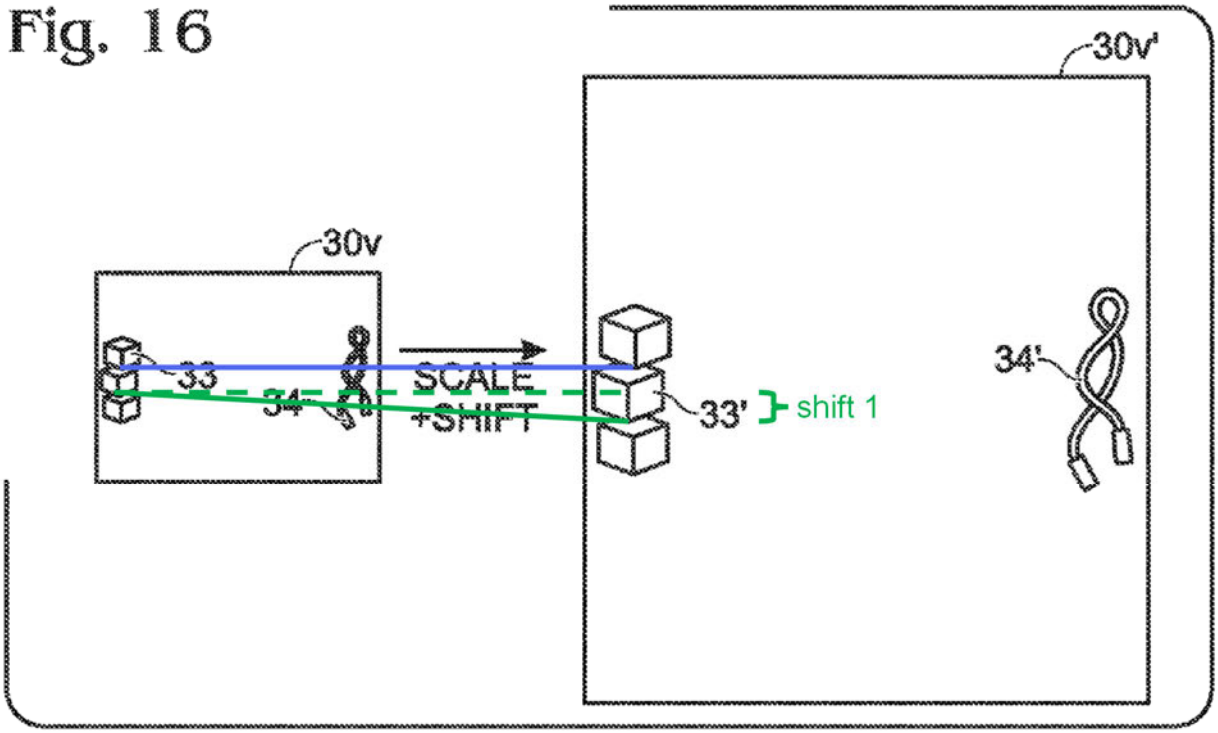
61. Dr. Foroosh also argues that Chao's shifting is not "non-uniform" because it only shifts foreground objects and does not shift them non-uniformly. (EX2027, ¶¶83, 86.) I disagree. Chao shifts the foreground objects differently,

and it also shifts the foreground objects differently than it shifts the background objects. Figure 14 of Chao (annotated below) shows that the shifts of the foreground objects are not the same in all parts or areas. Chao explains that "[o]n page 30*h*[1] which is wider than page 30h, the ducks are the same size as the ducks on page 30*h*, but have been spread out so that the ducks on page 30*h*[1] occupy the same relative space as the ducks on page 30*h*." (EX1008, [0091].) "[T]he ducks occupy the same position relative to each other that they had on page 30*h*." (EX1008, [0091].) The figures show that the positions of the ducks change, and the change is due to shifting the ducks (and their pixels) by different amounts (i.e., non-uniform shifting). For example, in Figure 14, the horizontal position of the beak of the outer left duck in the input image is shown with the vertical dashed green line, and the solid green line shows its shift (labeled "shift 1"). The horizontal position of the beak of the inner left duck in the input image is shown with the vertical dashed blue line, and the solid blue line shows its shift (labeled "shift 2"). As the picture shows, the shift of the outer left duck is different than the shift of the inner left duck. This difference in shift is due to the ducks being spread out (the aspect ratio of the white space between adjacent ducks is not preserved), despite the aspect ratio of each duck being preserved.

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62. In the Figure 16 example (annotated below), the bottom corner of the top cube in the input image has zero vertical shift applied, while the bottom corner of the middle cube has a non-zero amount of vertical shift applied (labeled "shift 1"). Thus, the shift of the top cube and its pixels is different than the shift of the middle cube and its pixels. Both cubes are foreground objects, but shifted differently.



63. Further, the foreground objects (*e.g.*, ducks) are shifted differently than the background objects. The "aspect ratio of all the elements in the foreground layer [(i.e., foreground objects)] is preserved," while the "background element is re-sized, by stretching or shrinking" thereby not preserving the aspect ratio of the background objects. (EX1008, [0028], [0090].) This difference in aspect ratios between the foreground and the background results in shifting the pixels of the foreground differently than shifting the pixels of the background. Dr. Foroosh's argument that Chao does not perform non-uniform shifting because it only shifts foreground objects incorrectly ignores the background. (EX2027, ¶¶86-88.) The background is part of the input image and cannot be ignored. Thus, Chao's shifting is non-uniform shifting.

F. A POSITA Would Have Been Motivated To Combine Meulen And Chao

64. As I explained in my opening declaration, a POSITA would have been motivated to combine Meulen and Chao. (EX1002, ¶¶263-264, 271.) Meulen does not disclose the details of scaling, which would motivate a POSITA to look to another reference such as Chao which discloses the details. Chao discloses that it performs aspect ratio conversion by stretching or shrinking. (EX1008, [0028], [0063].) Chao explains that "the terms 'stretch' and 'shrink' are intended to mean the resizing of an element without regard to the original aspect ratio of the image. Accordingly, a 'stretched' element may be elongated in only one direction, i.e. may be resized such that it is wider than the original element in the horizontal direction. . . ." (EX1008, [0063].) And Chao is like the '413 patent, which uses the term "stretched" when describing pixel shifting. (*See, e.g.*, EX1001, 4:9-13 ("[i]n the warping step 206, a non-linear warping is applied which results in the circles being stretched/compressed by different amounts depending on their horizontal and vertical positions resulting in example image 216.").) I note that Dr. Foroosh does not rebut the motivation to combine that I provided in my opening declaration. And there was a reasonable expectation of success given the overlap between Meulen and Chao and successful demonstration by the prior art.

65. Instead, Dr. Foroosh argues that a POSITA would not look to Chao because it addresses a different problem than Meulen. (EX2027, ¶90.) I disagree.

Meulen teaches an aspect ratio conversion method as an alternative to the prior art methods of "black bar[s]" (padding) and "cropping." (EX1007, 1:26-31, 2:2-6.) Chao teaches an aspect ratio conversion method as an alternative to the prior art methods of "simply scal[ing] an original image to fit a new page size without regard to the original design intent of the original image" (linear scaling) and "cropping." (EX1008, [0002].) Thus, both address the problems associated with cropping, padding, and linear scaling, which remove portions of the image, add unappealing black bars, or add noticeable distortion. The '413 patent addresses the same "common problem[s] in the field of image and video processing." (EX1001, 1:6-7.) Dr. Foroosh agreed that the '413 patent is trying to improve upon cropping, linearly scaling, and padding. (EX1015, 64:17-22.)

66. According to Dr. Foroosh, Meulen and Chao are different because Chao works with documents intended for printing, whereas Meulen works with media source content displayed on a device's screen. (EX2027, ¶90.) But working with documents for printing involves viewing and modifying the content on a device's screen before being printed, and thus, changing the aspect ratio of a document for printing is still changing the aspect ratio ("modifying content from a media source") of an image displayed on a device's screen. (EX2027, ¶90.) Further, this is just one embodiment of Chao. Chao is not just about printed documents, it discloses "[t]he image may be output by displaying the image on or

as part of: a display screen such as a computer monitor, camera screen, printer screen, printed page, projected image, or the like." (EX1008, [0032].) It also describes the input image as being a "digital image" having any format including, a "bitmap format such as .png, .tiff, .psd, etc." (EX1008, [0023].) The input images of the '413 claims and Meulen are digital images that may have these formats. (EX1015, 36:10-38:8.)

67. Dr. Foroosh also argues that Meulen tries to avoid distortion near the middle, while Chao tries to avoid distortion near the borders. (EX2027, ¶¶91-92.) But a POSITA would not have understood Meulen's and Chao's teachings to be so narrow. This is especially because Chao describes its invention as being directed more broadly to "automatically resizing an image while maintaining the original design intent of the original image." (EX1008, [0022].) And Meulen's invention is directed more broadly to "image compression and/or scaling . . . applied to media content having an aspect ratio and/or resolution that is different from the aspect ratio and/or resolution of the display. . . . [w]ith more image compression . . . applied to the media content which is to be displayed at or near the edges of the display than to the media content which is to be displayed at or near the central region." (EX1007, 1:55-2:2.)

68. A POSITA would have known that the objects of interest in an image may be in the central region like in Meulen, or may be at the edges like in Chao.

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Meulen applies zero compression at the central region where the objects of interested are located, and Chao similarly preserves the aspect ratio of the foreground objects (objects of interest). (EX1008, [0090].) Thus, both teach aspect ratio conversion (non-uniform shifting) with minimal distortion where the objects of interest (design intent) are located. Further, Chao's method for processing foreground objects differently than background objects is similar to Meulen's method for processing the central region (where foreground objects are typically located) differently than the lateral regions (where background objects are typically located). The references processing foreground objects/central region differently than background objects/lateral regions shows that each teaches "determining a portion within the input image."

69. Additionally, Chao's teachings are not limited to stretching/shrinking only the background and uniformly scaling the foreground objects. (EX2027, ¶93.) Chao discloses that "elements can be determined to be either foreground or background elements based on their position and ***other characteristics*** within the context of the original image." (EX1008, [0025] (emphasis added).) And Chao's Figure 14 example of ducks that are the same size and occupy the same relative space is not a concern that applies solely to what Dr. Foroosh calls "graphic design." (EX2027, ¶93.) It applies to images that contain objects, such as images that are resized (compressed and/or scaled) like the images in Meulen. Further, I

do not agree with Dr. Foroosh that there is no meaningful way to identify objects in Meulen's image. (EX2027, ¶93.) As I pointed out in my opening declaration, identifying objects in an image was known by a POSITA at the time of the '413 patent. Prior art such as Liu and Chao disclose methods for identifying objects. (EX1002, ¶¶140, 305.)

G. Meulen Teaches "the transformation non-uniformly shifts the pixels from the input positions to the output positions based on (1) the input positions along the first axis, and (2) the input positions along the second axis" (Limitations 1[g] And 2[e])

70. Limitations 1[g] and 2[e] require that the transformation non-uniformly shifts the pixels "based on (1) the input positions along the first axis, and (2) the input positions along the second axis." A POSITA would have understood this limitation to mean the shift is based on the input positions. For example, the pixels having input positions at the center may not be shifted at all (zero amount), while pixels having input positions at the edge may be shifted by a non-zero amount. (EX1001, 4:14-36.)

71. This interpretation is consistent with the embodiments disclosed in the '413 specification, encompassed by the '413 claims. In some embodiments, non-uniform pixel shifting is performed along only one axis, such as the horizontal axis. The passage at 6:65-66 of the '413 specification states "the horizontal warp distortion in one embodiment is a function of the horizontal position only." The

passage at 5:49-51 states that "[i]n this embodiment, the horizontal warp is [a] function of the horizontal coordinate only and is independent of [the] vertical position." And the passage at 6:26-28 states "[t]he image center could be fully corrected using the horizontal direction only (no vertical warping)." The equation at 6:65-7:5 similarly is "a function of the horizontal position only." (EX1001, 6:65-66.) Thus, Dr. Foroosh's interpretation that limitations 1[g] and 2[e] require non-uniform shifting for both directions is incorrect. (EX2027, ¶¶94-95.)

72. Meulen nevertheless discloses an embodiment that non-uniformly shifts in both directions. (EX2027, ¶96.) It discloses its image compression and/or scaling as being "applied in a horizontal direction and/or in a vertical direction." (EX1007, 10:19-26.) Dr. Foroosh acknowledges this passage, but alleges that the compression/scaling in the vertical direction is uniform. (EX2027, ¶¶98-99.) I disagree. The paragraph uses the same "image compression and/or scaling" phrase that Meulen uses to describe its non-uniform shifting. Meulen uses the term "image compression and/or scaling" and then explains that it "may be applied to media content having an aspect ratio and/or resolution that is different from the aspect ratio and/or resolution of the display. . . . For example, more image compression may be applied to the media content which is to be displayed at or near the edges of the display than to the media content which is to be displayed at or near the central region." (EX1007, 1:55-2:1.) Further, the passage at 10:21-26

describes the image compression and/or scaling "[w]hen applied in both the horizontal and vertical direction" as "allow[ing] expansion of the lateral display regions 202-1-2 and 202-6-9 to create a magnified effect. . . ." A POSITA would have understood that the dimensions of the display, including the vertical dimensions, are fixed (*e.g.*, 320). Creating a magnified effect means enlarging some pixels. Enlarging some pixels would require compressing other pixels since the vertical dimension is fixed. Because some pixels are enlarged and some pixels are compressed, Meulen teaches non-uniform compression/scaling in the vertical direction.

73. This understanding is consistent with claim 8 of Meulen. Claim 8 depends from claim 1. Claim 1 requires Meulen's "wireless device [] compress said media source content" for aspect ratio conversion (non-uniform shifting). Claim 8 requires "apply[ing] compression to at least one of a horizontal direction [and] a vertical direction." Thus, claim 8 specifies that Meulen's non-uniform compression is in the horizontal direction, the vertical direction, or both.

74. Dr. Foroosh alleges that my testimony confirms that Meulen's compression is only in the horizontal direction. (EX2027, ¶97 (citing EX2026, 47:3-13).) I would like to clarify that my testimony is specifically discussing Meulen's Table 1 embodiment, not every embodiment of Meulen. (EX2026, 47:3-13 ("Q. And the change in compression ratio for table 1 depends only on how far

that region is horizontally from the center, correct?" "A. This particular example, the further away from region 3, excuse me, the higher the compression ratio.")).) And as Dr. Foroosh stated, Table 1 is just "one specific implementation" of Meulen. (EX2027, ¶48.)

H. Meulen Teaches Limitations 1[pre], 1[b]-1[d], 1[h], 1[i], 2[pre]-2[b], 2[f], And Claim 7

75. I explained and showed that Meulen teaches limitations 1[pre], 1[b]-1[d], 1[h], 1[i], 2[pre]-2[b], 2[f], and claim 7. (EX1002,¶¶248-251, 265-271, 293-295, 309, 310, 313-315, 319, 320.) Dr. Foroosh does not dispute that Meulen teaches limitations 1[pre], 1[b]-1[d], 1[h], 1[i], 2[pre]-2[b], 2[f], and claim 7.

I. Chao Teaches Claims 6 And 7

76. I explained and showed that Chao teaches claims 6 and 7. (EX1002,¶¶291, 294.) Dr. Foroosh does not dispute that Chao teaches claims 6 and 7.

V. FLEMING

A. A POSITA Would Have Been Motivated To Perform Fleming's Non-Uniform Shifting Of Pixels Of An Input Image By "one or more physical processors [] included within a camera" (Claim 6)

77. As I explained in paragraph 17, neither claim 2 nor claim 6 requires an "image sensor" or that the "input image" be captured from the image sensor of the "system" of claim 2 or the "camera" of claim 6.

78. For claim 6, Dr. Foroosh argues that there is no reason for Fleming to perform aspect ratio conversion because there is no difference between the aspect ratios of the input image and the display. (EX2027, ¶107.) This is incorrect. Fleming describes its invention as applying "[w]hen the target display area is capable [of] displaying a different number of rows or a different number of columns of pixels than those of the given video image, ..." (EX1004, 1:17-20.) Thus, Fleming discloses a difference in the aspect ratios of the input image and the display.

79. Fleming teaches "apply[ing] a transformation to the input image," where "the transformation non-uniformly shifts the pixels." (EX1002, ¶¶63-81.) Dr. Foroosh does not dispute this. And in my opinion, it would have been obvious to a POSITA to apply the transformation (non-uniform shifting) by one or more processors included within a camera. (EX2027, ¶105.)

1. A POSITA would have been motivated to have the processor(s) included within a camera perform non-uniform shifting

80. A POSITA would have been motivated to have the processors included within the camera perform non-uniform shifting of pixels because doing so leads to benefits of being less burdensome, cheaper, and saving time. (EX1002, ¶¶100, 202.) It would be less burdensome, cheaper, and saves time because the alternative would be to perform non-uniform shifting of pixels on a separate

device. (EX2027, ¶107.) The images/video would need to be transferred from the camera to the separate device, and then the separate device would need to perform the non-uniform shifting. The separate device itself costs money and would be burdensome to carry around. And connecting the separate device to the camera also costs money (e.g., the costs of the cable for connecting the two devices) and takes time. Transferring the images/video from the camera to the separate device would also be burdensome and take up more time. And then operating the separate device to perform non-uniform pixel shifting would further add to the burden and time needed. A POSITA would have known about these benefits. For example, the Canon PowerShot G15, available at the time of the '413 patent, was noted as being "a well rounded instrument that minimalists can rely on in photographic situations when carrying large heavy gear isn't an option." (EX1026, 3.)

81. It was known at the time of the '413 patent (2013) for digital cameras to include displays. Users of digital cameras often captured images using the image sensor of the camera followed by previewing the captured images shortly after using the display. The ability to preview the image shortly after capturing the image had many benefits. It allowed the user to quickly and easily determine whether or not to capture the image again, whether to modify the camera settings, whether to change environments or scenery, which objects to add or exclude from the image to be captured, etc. Many digital cameras included built-in displays for

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this capability, which a POSITA would have found beneficial and would have motivated a POSITA to have the processor(s) included within the camera perform the non-uniform pixel shifting.

2. Digital cameras having an image sensor with an aspect ratio different from the aspect ratio of the stored files or display were known at the time of the '413 patent

82. At the time of the '413 patent, there were digital cameras that captured an image and displayed that captured image on the camera's built in display. Dr. Foroosh agreed. (EX1015, 77:9-21.) There were digital cameras at the time of the '413 patent that had a need for aspect ratio conversion. Some cameras at the time had an image sensor having one aspect ratio, such as 3:2 or 4:3, and displayed or stored files of the captured images having another aspect ratio, such as 16:10, 16:9, or 4:3. (EX1002, ¶¶100, 201.) For example, the Canon PowerShot G15 was released on September 17, 2012 (before the '413 patent). (EX1027, 1-2.) It had an image sensor with an aspect ratio of 4:3. The camera allowed the user to select among five different aspect ratios of 16:9, 3:2, 4:3, 1:1, and 4:5 based on the application. (EX1028, 80; EX1035; EX1029, 1.) The 16:9 aspect ratio is "[u]sed for display on widescreen HDTVs or similar display devices." (EX1028, 80.) The 3:2 aspect ratio is used to achieve the "[s]ame aspect ratio as 35mm film, used for printing images at 5 x 7-inch or postcard sizes." (*Id.*) The 4:3 aspect ratio is the "[n]ative aspect ratio of the camera screen, also used for

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displaying on standard-definition televisions or similar display devices, or for printing images at 3.5 x 5-inch or A-series series sizes." (*Id.*) The 1:1 aspect ratio is selected when the user desires a "[s]quare aspect ratio," and the 4:5 aspect ratio is "commonly used for portraits." (*Id.*) As the user manual explains, "[o]nce the setting is complete, the screen aspect ratio is updated." (*Id.*) This means that the image sensor captures an image having a 4:3 aspect ratio, and then the display shows the image or the processor saves the image having the aspect ratio of the setting. The user may set the aspect ratio of the image displayed/saved to an aspect ratio that is different from the aspect ratio of the image sensor. Thus, the Canon PowerShot G15 is one example camera available at the time of the '413 patent that had an image sensor having one aspect ratio, and displayed/saved images having another aspect ratio, showing aspect ratio conversion by processor(s) included within a camera.

83. Other example cameras available at the time of the '413 patent that had an image sensor having one aspect ratio, and displayed or stored images having another aspect ratio include the Olympus PEN E-PL5 (image sensor aspect ratio of 4:3 and display aspect ratio of 16:9, available on Sept. 17, 2012) (EX1030; EX1027), Fujifilm XF1 (image sensor aspect ratio 3:2 and displays/stores images having aspect ratios of 3:2, 4:3, 16:9, and 1:1, available on Sept. 17, 2012) (EX1033, 1-2; EX1027), and Casio Exilim EX-ZR 1000 (image sensor aspect ratio

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of 3:2 and display aspect ratio of 16:9, available on Sept. 25, 2012) (EX1031; EX1027).) This shows that Dr. Foroosh's testimony that there is no evidence and no reason for a digital camera to have an image sensor with one aspect ratio and a display with a different aspect ratio is incorrect. (EX1015, 89:7-90:1.)

3. A POSITA would have been motivated by the benefits of non-uniform shifting

84. The cameras at the time of the '413 patent, such as the ones discussed in paragraphs 82 and 83, had processors included within the camera that performed aspect ratio conversion. In some instances, the in-camera processors performed aspect ratio conversion techniques that had downsides, such as the cropping performed by the processors included in the Canon PowerShot G15, which led to "[c]ropped images . . . hav[ing] a smaller resolution than uncropped images," thereby removing content from the images. (EX1028, 208.) The Olympus PEN E-PL5 camera had a 16:9 display, "which is great for video but leaves a lot of unused real estate in the form of black bars when you're shooting in the native 4:3 aspect ratio of the sensor." (EX1030.) Thus, a POSITA would have recognized that the other aspect ratio conversion techniques at the time of the '413 patent had downsides, such as image loss (from cropping), black bars (from padding), and perceivable distortion (from linear distortion).

85. A POSITA would have known about cameras at the time of the '413 patent that performed aspect ratio conversion techniques by a processor included in

the cameras. A POSITA also would have known that there were problems with cropping, padding, and linear distortion, and thus would have been motivated to apply a different aspect ratio conversion technique that did not have problems of removing content from the images or leaving a lot of unused real estate in the form of black bars. Prior art such as Meulen, Fleming, and Obara offered solutions to these problems.

86. Dr. Foroosh argues that a POSITA would prefer that the camera and display have the same aspect ratio or not perform any aspect ratio conversion at all. (EX2027, ¶¶108, 111, 114, 115.) Dr. Foroosh's arguments are incorrect and irrelevant because the '413 patent claims are directed to aspect ratio conversion (to which he agreed (EX1015, 62:23-63:1)) where the aspect ratio of the input image is different than the aspect ratio of the output image. The '413 patent is like Fleming, Obara, and Meulen, each teaches non-uniform shifting for an input image having one aspect ratio and an output image having a different aspect ratio. Dr. Foroosh's cited exhibits (EX2004 and EX2005) are also irrelevant because each describes a wide-angle camera that corrects the distortion in the image introduced by the wide-angle lens. (EX2027, ¶114 (citing EX2004 and EX2005).) These exhibits are not directed to aspect ratio conversion. Here, the issue is whether a POSITA would have been motivated to perform non-uniform shifting (as taught by Meulen, Fleming, and Obara) by a processor included within a camera. The issue

is not whether a POSITA would have been motivated to avoid distortions entirely—an issue not relevant to the '413 patent, Fleming, Obara, or Meulen. Dr. Foroosh agree that the '413 patent is not trying to avoid distortions, and testified that "[a]ctually, I think the '413 patent went out of its way back at the [priority] date to come up with the concept of introducing distortions." (EX1015, 64:23-65:15.)

87. I disagree with Dr. Foroosh's argument that a POSITA would not be motivated because it was conventional to reduce as much distortion as possible. (EX2027, ¶106.) I also disagree that a POSITA would always prefer techniques such as cropping, linear scaling, or padding. (EX2027, ¶109.) Some applications involve performing aspect ratio conversion, where a POSITA would not have preferred cropping, padding, or linear scaling over non-uniform shifting. This is because cropping, padding, and linear scaling remove portions of the image, add black bars, or add noticeable distortion. Even the '413 patent acknowledges that these are "common problem[s] in the field of image and video processing." (EX1001, 1:6-7.) It states that "cropping removes content from the image and reduces the field of view of the image. Linear scaling . . . introduces perceivable distortion into the image. . . . Padding maintains the full field of view without distortion, but results in unused display space around the sides and/or top of the image, thus rendering an image that appears too small relative to the display."

(EX1001, 1:14-25.) And this may be true even if that means more processing and shorter battery life because in some situations, the benefits are high, but the costs are small (*e.g.*, capturing high-quality panoramic images that requires non-uniform shifting, but only a few images are needed).

88. I also disagree with Dr. Foroosh's argument that non-linear distortions are undesirable because it makes the scene look unnatural. (EX2027, ¶112.) The prior art that I discuss in my opening declaration and in this reply declaration (Fleming, Obara, Meulen, Chao, and Liu) teach methods that shift the distortion in a manner that minimizes how noticeable the distortion is. For example, an image with an object of interest in the center may look natural if the distortion is located elsewhere, such as at the edges where the object of interest is not located. Even Dr. Foroosh admits that there are applications where non-linear distortions are "more appropriate." (EX2027, ¶113.) And Patent Owner stated that non-linear distortion is useful for as "'body- and gear-mounted shots' where one may be 'shooting in a tight space' or 'want to make sure that your subject remains in the frame.'" For such applications, a POSITA would have been motivated to apply non-uniform shifting because the benefits (avoiding the downsides of cropping, padding, and linear scaling such as removing portions of the image, adding black bars, or adding noticeable distortion) outweigh the small costs of applying the non-

uniform shifting to the input image. The costs are particularly small for Fleming as its non-uniform shifting involves simple operations, as I discuss in paragraph 89.

4. A POSITA would have been motivated to apply Fleming's method by processor(s) included within a camera

89. Fleming itself disclosed a nonlinear scaling that applies a transformation using a simple math equation: $Y=y(A+(B-A)\times(y/H)^2)$ as an example. (EX1004, 6:18-27.) This math is simple because it involves basic math operations of addition, subtraction, and multiplication. "A" and "B" are linear scaling factors (constant values), H is half the height of the video image (also a constant value). These are math operations that a processor included in a camera in 2013 would be able to easily perform. This math equation is simpler than other image processing functions (e.g., interpolations) performed by the processors included within the camera at the time.

90. Dr. Foroosh argues that non-uniform transformations must be performed off camera because they involve complex operations. (EX2027, ¶57.) I disagree. The non-uniform transformation may involve simple operations that can be performed by a processor included within a camera. For example, the Canon PowerShot G15, available by the '413 patent, was "equipped with a new Digic V processor, that helps the G15 process complex equations faster than previous cameras." (EX1026, 2.) A POSITA would have expected the processors already

included within some of the cameras at the time of the ’413 patent to be able to process Fleming’s simple equations.

5. There would have been a reasonable expectation of success

91. Additionally, there would have been a reasonable expectation of success. (EX2027, ¶¶106, 116.) As I discuss in paragraph 89, Fleming’s non-uniform shifting is not complicated and involves simple equations. The prior art had on-camera processing capabilities, as Dr. Foroosh admits. (EX2027, ¶110.) The prior art and evidence has demonstrated that the processors included in cameras at the time of the ’413 patent were capable of processing equations more complex than Fleming’s equations. Because the prior art already demonstrated that processors included in cameras had the capability of processing Fleming’s non-linear scaling math operations and applying their non-uniform shifting, there would have been a reasonable expectation of success. (EX1002, ¶100.)

B. Fleming Teaches “determin[ing] a portion within the input image” (Limitations 1[e] And 2[c])

92. As I discuss in paragraphs 12-15, the ’413 claims do not require that the “determin[ing] a portion within the input image” be performed after “obtain[ing] the[/an] input image” and prior to “apply[ing] a transformation.” (EX2027, ¶117.)

93. There are multiple passages in Fleming that show that it "determine[s] a portion within the input image," including after obtaining the input image and prior to applying the transformation. (EX2027, ¶¶118-119.)

94. "determin[ing]" to preserve the original aspect ratio. In the Abstract, Fleming states that "the nonlinear functions are such that the original aspect ratio of the video image is preserved near the center region (or strip) of the image and the image is gradually stretched (or compressed) as it is mapped to the edges." (EX1004, Abstract, 1:41-45; *see also id.*, 5:23-26.) Fleming describes certain portions in the input image as being determined so that the original aspect ratio is preserved: "[t]o preserve the original aspect ratio near the center of image 271, nonlinear mapping according to non-linear curve 241 is used to map the positions of the vertical lines along the horizontal direction." (EX1004, 4:49-54.) And the portions in the input image are determined so that they can be mapped to corresponding portions in the output image. "[A] square region at the center of image 271 is mapped (or scaled) as a square (or a rectangle substantially close to a square) in image 273." (EX1004, 5:1-4.) A POSITA would have understood that Fleming determines a region (portion), such as a center region, in order to preserve the original aspect ratio of the determined region. Without a determination, the "original aspect ratio" may not be "preserved near the center region [(the region of interest)]," and the image may not be "gradually stretched (or compressed) as it is

mapped to the edges." (EX1004, Abstract.) In other words, a POSITA would have understood that Fleming teaches "determin[ing] a portion within the input image" because this determination helps Fleming achieve its objectives.

95. Dividing the original video image. Fleming even states that "[d]ifferent schemes can be used in ***determining*** the strips and coordinates for instructing the graphics hardware to perform the scaling. For example, the ***original video image*** can be divided into evenly spaced strips so that the graphics hardware can scale them into strips of different widths for the frame buffer. Alternatively, the original video image may be so divided that, after the scaling, the corresponding strips have the same width." (EX1004, 7:3-10 (emphases added).) The passage at 7:15-16 states "[a] frame of video image from video data 601 is divided into a number of rectangular regions (603)." Thus, Fleming teaches "determin[ing] a portion within the input image" after the input image is obtained.

96. Order of steps in the figures. Fleming's figures also show that it teaches "determin[ing] a portion within the input image" after the input image is obtained and before applying a transformation. Figure 10 (annotated below) shows operation 811, operation 813, and operation 815, performed in that order. "Operation 811 receives a first video stream of a first aspect ratio"—*i.e.*, ***"obtain[ing] an input image."*** (EX1004, 8:48-54.) Then "[o]peration 813 divides each frame of the first video stream into a plurality of frame regions"—*i.e.*,

"determin[ing] a portion within the input image." (EX1004, 8:48-54.) After that, "[o]peration 815 scales the plurality of frame regions (e.g., using a graphics processing unit) according to more than two scaling factors along one direction to generate data for a plurality of regions in a frame buffer"—*i.e.*, ***"apply[ing] a transformation."*** (EX1004, 8:48-54.) This shows that Dr. Foroosh is incorrect. Fleming determines a portion within the input image (operation 813) after the input image is obtained (operation 811), and determines the portion before applying a transformation (operation 815).

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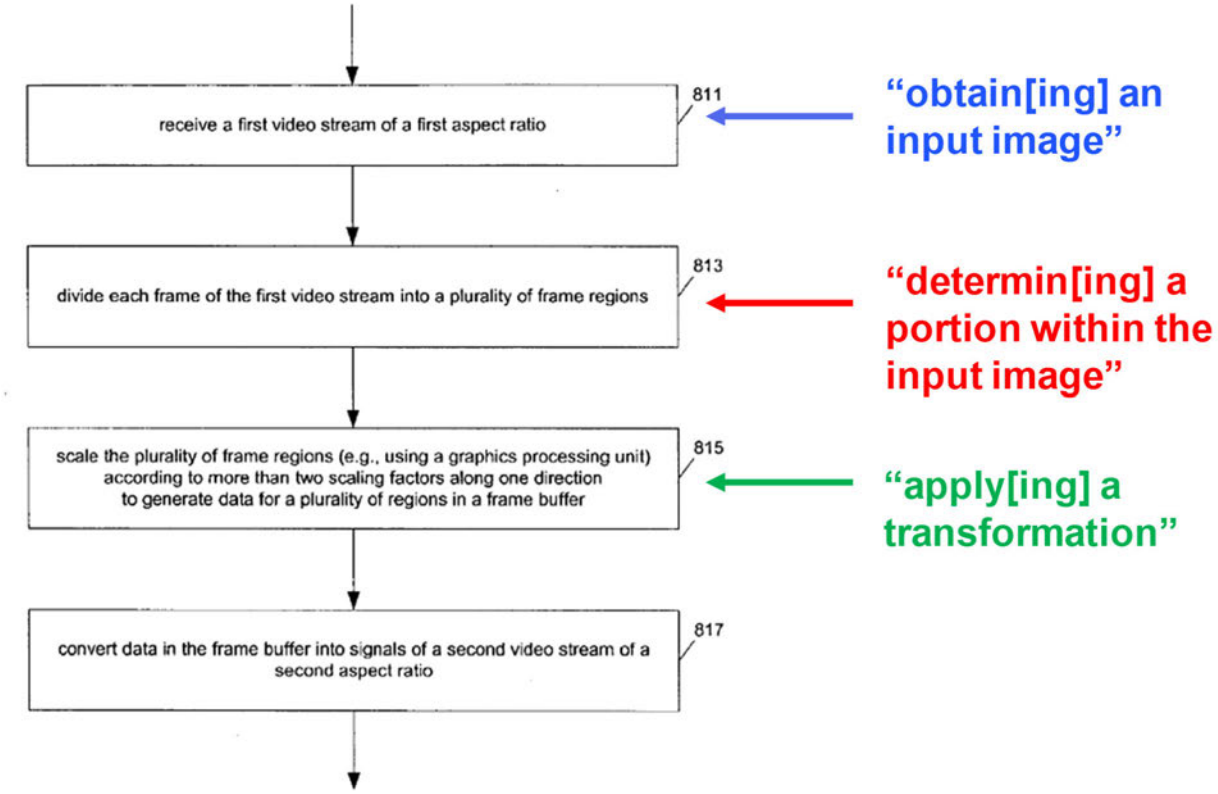


Fig. 10

97. Figure 11 (below) shows operation 833, operation 835, and operation 839, performed in that order. "Operation 833 receives a first video stream of a first aspect ratio in a first color space (e.g., YUV). Operation 835 divides each frame of the first video stream into a plurality of frame regions (e.g., evenly, or, according to the nonlinear transform). For example, the frame of the first video stream can be so divided that these regions, after the scaling, will be of even size on the target display area. . . . Operation 839 scales the plurality of frame regions using

graphics hardware (e.g., a graphics processing unit) according to the parameters to generate data a frame of a second video stream of a second aspect ratio in a second color space (e.g., RGB)." (EX1004, 8:63-9:9.) This is yet another figure that shows that Fleming teaches limitations 1[e] and 2[c].

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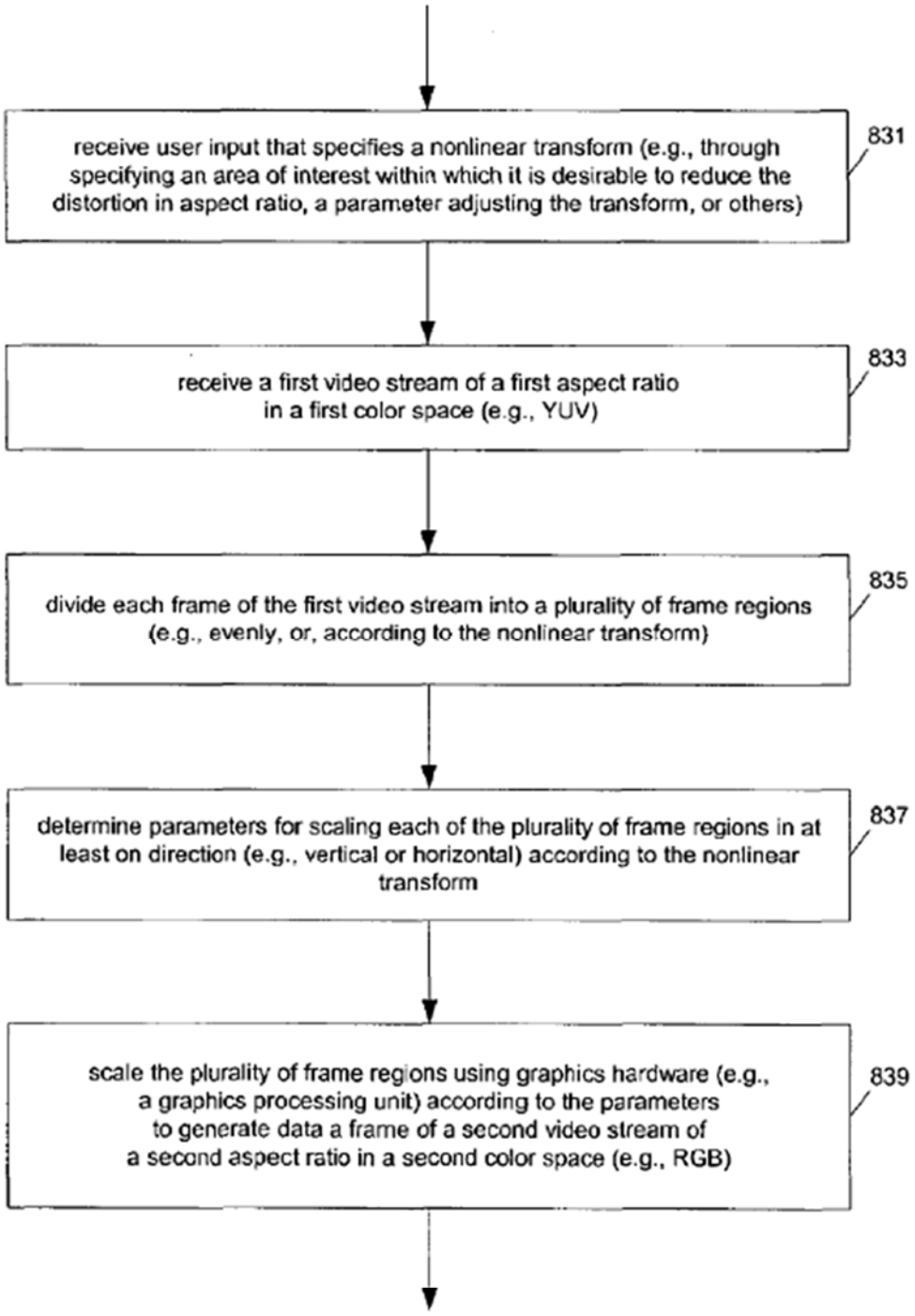


Fig. 11

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98. "determin[ing]" based on user input. Fleming also teaches determining a portion within an input image based on user input. "In one example, user input is received to specify the nonlinear scaling; and, the plurality of regions for nonlinear scaling are determined according to the user input." (EX1004, 2:15-18.) The plurality of regions being determined *for* nonlinear scaling means they are determined before applying the non-uniform shifting. The determination is not "simply describ[ing] the effect of the transformation," as Dr. Foroosh alleges. (EX2027, ¶120.) Fleming also discloses:

- "In one embodiment of the present invention, a user specifies the area of interest; and, the nonlinear scaling is constructed according to the location and the size of the area of interest." (EX1004, 6:12-15.)
- "In one embodiment of the present invention, the nonlinear scaling (e.g., the location and size of the area of interest) is adjustable by a user so that the user can adjust the scaling in real time according to the user's preferences." (EX1004, 7:34-37.)
- "Functions other than the cubical polynomial can also be used. For example, a curvefit function generated based on a number of control points can be used. The control points can be predefined or received from user input devices (e.g., through a control button, or a graphical user interface, or a voice recognition system)." (EX1004, 6:30-35.)

The nonlinear scaling being constructed or adjusted according to a user-specified area of interest shows that Fleming's determination step is not programmed, as Dr. Foroosh alleges. (EX2027, ¶121.) Dr. Foroosh argues that Fleming performs the "determin[ing]" and "apply[ing]" in one step. He cites 4:49-51 of Fleming, which states "[i]n the example of FIG. 2, image 271 is scaled nonlinearly in the horizontal direction." But this passage refers to "scal[ing] nonlinearly"—the passage does not mention an area of interest. (EX2027, ¶121.)

99. Additionally, it would have been obvious to a POSITA that determining the portion would be after the image is obtained because the user input would be based on the captured image. For example, "[i]n one embodiment of the present invention, the nonlinear mapping is constructed according to a polynomial mapping; and, the coefficients of the polynomial are adjustable by a user to trade off distortion between the image center and the image edges, giving the user control over the location and the amount of distortion." (EX1004, Abstract.) In this embodiment, the user views the captured image and associated distortion before determining the portion so that the user may control the location and amount of distortion of the output image. (*See also* EX1004, 7:34-37 ("In one embodiment of the present invention, the nonlinear scaling (e.g., the location and size of the area of interest) is adjustable by a user so that the user can adjust the scaling in real time according to the user's preference.").)

100. "determin[ing] based on an area of interest. Fleming also describes the determination being based on an area of interest, which would be determined for purposes of preserving the aspect ratio. It would have been obvious that determining the input image would be after obtaining the input image because the input image would need to be obtained in order for the area of interest to be determined. Fleming discloses:

- "At least one embodiment of the present invention seeks to preserve the original aspect ratio near an area of interest using nonlinear scaling of video images." (EX1004, 4:29-31.)
- "According to one embodiment of the present invention, it is desirable to maintain the original aspect ratio in an area of interest (e.g., at the center of the image) and gradually stretch the image in other areas. Thus, the image in the area of interest is presented in the target display area with reduced distortion (or with no distortion), while other areas are distorted." (EX1004, 4:38-45.)
- "Since the detail at the center strip is typically of more interest to a viewer, the nonlinear scaling in the example preserves the original feature of the video image in the area of interest, the center strip." (EX1004, 5:29-32.)
- "In general, linear scaling in both directions can also be combined with nonlinear scaling (either in the vertical direction or in the horizontal

direction) so that the aspect ratio of the area of interest (e.g., the center strip) is preserved." (EX1004, 5:35-39.)

- "To fit the video image into the display area of display device 737**,** scaling circuit 733 nonlinearly scales the video image (e.g., to preserve the original aspect ratio of the video image at an area of interest, such as the center region or center strip of the display device)." (EX1004, 8:16-21.)

These passages show that Fleming determines a portion (*e.g.*, center region) within an input image so that the aspect ratio of the portion may be preserved. To ensure that the aspect ratio that is preserved is in a specific region, it would have been obvious for the region/portion to be determined.

101. Functions. Fleming also discloses functions used for non-uniform shifting that are just like the functions for the '413 patent. According to Dr. Foroosh, the functions for the '413 patent satisfy the "determin[ing]" limitation of the '413 claims. The '413 patent describes that "the conversion is achieved using a resolution remapping that applies a nonlinear function across the image so as to minimize or reduce undesirable key feature aspect ratio distortions." (EX1001, 3:39-45; EX2027, ¶122.)

102. Fleming similarly applies a nonlinear function across the image to minimize/reduce undesirable key feature aspect ratio distortions, as disclosed in several passages:

- "To preserve the original aspect ratio near the center of image 271, nonlinear mapping according to non-linear curve 241 is used to map the positions of the vertical lines along the horizontal direction. For example, the vertical line at $x=x_4$ (214) in image 271 is mapped to the vertical line at $X=X_4$ (204) in image 273. . . . Thus, a square region at the center of image 271 is mapped (or scaled) as a square (or a rectangle substantially close to a square) in image 273." (EX1004, 4:51-5:4.)
- "Nonlinear curve 343 is used to map the vertical lines of image 371 from positions 302-204 to positions 312-314 (on line 341), and 322-324 to 332-334. . . . Since the detail at the center strip is typically of more interest to a viewer, the nonlinear scaling in the example preserves the original feature of the video image in the area of interest, the center strip." (EX1004, 5:19-32.)
- "Curve 411 is used to map the horizontal positions of the vertical lines; and curve 413 is used to map the vertical positions of the horizontal lines. Thus, while the aspect ratio of the portions of the image near the boundary is distorted, the aspect ratio of the center region of the image is preserved." (EX1004, 5:46-51.)
- "Various nonlinear curves can be used for the construction of nonlinear scaling. For example, a cubical polynomial can be used to map the

coordinates. . . . the image can be . . . nonlinearly scaled in the vertical direction using mapping $Y=y(A+(B-A)\times(y/H)^2)$." (EX1004, 6:16-24.)

- "The data specifying the non-uniform mapping (505) is used to define the scaling of each of strips using graphics hardware (e.g., graphics processing unit (GPU) 507)." (EX1004, 6:50-53.)
- "After receiving a first video image of a first aspect ratio in block 901, a nonlinear mapping function is constructed which scales the first video image to generate a second video image of a second aspect ratio. Then, the nonlinear scaling based on this mapping function is performed using texture functionalities of graphics hardware, as indicated in block 903." (EX1004, 9:14-20.)
- "determining a nonlinear function . . .; performing nonlinear scaling of the first video image . . . according to the nonlinear function." (EX1004, Claim 1.)

Thus, Fleming teaches "determin[ing] a portion within the input image" including after "obtain[ing] the[/an] input image" and prior to "apply[ing] a transformation."

C. Fleming Teaches Limitations 1[pre]-1[d], 1[f]-1[i], 2[pre]-2[b], 2[d]-2[i], And Claim 7

103. I explained and showed that Fleming teaches limitations 1[pre]-1[d], 1[f]-1[i], 2[pre]-2[b], 2[d]-2[i], and claim 7. (EX1002,¶¶46-58, 63-88, 101, 102,

114-120, 122-125.) Dr. Foroosh does not dispute that Fleming teaches limitations 1[pre]-1[d], 1[f]-1[i], 2[pre]-2[b], 2[d]-2[i], and claim 7, including that Fleming teaches the non-uniform shifting of the '413 patent.

VI. OBARA-LIU

A. A POSITA Would Have Been Motivated To Perform Obara's Non-Uniform Shifting Of Pixels Of An Input Image By "one or more physical processors [] included within a camera" (Claim 6)

104. As I explained in paragraphs 17 and 18, neither claim 2 nor claim 6 requires an "image sensor" or that the "input image" be captured from the image sensor of the "system" of claim 2 or the "camera" of claim 6.

105. Obara teaches "apply[ing] a transformation to the input image." (EX1002, ¶¶166-174.) And in my opinion, it would have been obvious to a POSITA to apply the transformation by one or more physical processors included within a camera. (EX1002, ¶¶200-202.) As I show in paragraphs 82 and 83, there were digital cameras at the time of the '413 patent that had an image sensor having one aspect ratio, such as 3:2 or 4:3, and a display having another aspect ratio, such as 16:10 or stored files of the captured image in another aspect ratio, such as 16:9. (EX2027, ¶¶106, 107; EX1002, ¶¶100, 201.)

106. Dr. Foroosh does not independently argue that Obara does not teach non-uniform shifting of an input image by "one or more physical processors [] included within a camera," that a POSITA would not be motivated to perform non-

uniform shifting, or that there is no reasonable expectation of success. (EX2027, ¶126.) Instead, Dr. Foroosh references the arguments he made for Fleming and alleges that "these arguments [for Obara] fail for the same reasons I discussed for Ground 1. . . ." (EX2027, ¶126.) As I discuss in paragraph 86, Dr. Foroosh's arguments that a POSITA would prefer that the camera and display have the same aspect ratio or not perform any aspect ratio conversion are irrelevant and incorrect.

107. In Obara, there is a difference between the aspect ratios of the input image and the output image. Obara describes its invention as "execut[ing] a non-linear scaling process of vertically dividing input image data having a first size into a plurality of image blocks and horizontally reducing at least one of the image blocks, which belongs to a central area of the input image data, and a display controller which enlarges the input image data, which is subjected to the non-linear scaling process, by linear scaling, generates output image data having a second size greater than the first size, and displays the generated output image data on a display device." (EX1006, Abstract.)

108. As I showed in paragraph 80, a POSITA would have been motivated to apply a transformation that non-uniformly shifts the pixels by a processor included within a camera because of the benefits of being less burdensome, cheaper, and saving time. (EX2027, ¶110; EX1002, ¶¶100, 202.) Further, as I showed in paragraphs 35 and 110, not all non-uniform transformations were

expensive, and not all non-uniform transformations involve complex operations, as Dr. Foroosh alleges. (EX2027, ¶¶108, 111.) I also showed in paragraph 88 that a POSITA would not always want to reduce as much distortion as possible, and a POSITA would not always prefer techniques such as cropping, linear scaling, or padding.

109. There are applications where a POSITA would want to perform non-uniform shifting because, *e.g.*, using the full size of the available display screen allows keeping all pixels captured by the image sensors. Some digital cameras use a display having an aspect ratio, such as 16:9, different from the aspect ratio of the image sensor, such as 4:3. One reason for the differences in aspect ratio is to allow different modes of operation, *e.g.*, video mode, panoramic mode, still image mode, etc., or to use a display screen that has a different aspect ratio Aspect ratio conversion techniques were used to handle these differences in aspect ratio. However, certain aspect ratio conversion techniques had disadvantages. For example, cropping removes portions of the image. Linear scaling introduces perceivable distortion into the image, and padding introduces black bars on the sides. Another option is non-uniform shifting where the aspect ratio at certain portions of the image, such as where objects of interest are located, may be preserved and any distortion may be shifted to other portions of the image. Since

the perceivable distortion is located at portions of the input image that the human eye does not focus on, the image looks close to natural.

110. Obara discloses a nonlinear scaling that applies a transformation that uses simple math operations and methods for reducing computational resources. "In the present embodiment, in order to realize a size altering process (enlargement/reduction) of image data, which is necessary for a non-linear scaling process, by ***an arithmetic process with a relatively light load***, the size altering process is executed with enlargement ratios each corresponding to an integer number of times of 1/(a power of 2), i.e. an integral multiple of $1/2^n$ (n is an integer). Thereby, a pixel interpolation process for altering the size of an image in the horizontal direction can be realized by ***only an arithmetic process including bit shift and multiplication of integers, and the load on the CPU 111, which is necessary for the size altering process, can greatly be reduced***." (EX1006, [0047] (emphases added).) A POSITA would have understood that bit shifting and multiplying by integers are not complex operations.

111. Obara also discloses a formula that involves simple math operations of addition, subtraction, multiplication, and division. (EX1006, [0072].) Obara explains that the formula may be made even more simple "by setting the enlargement ratio (n/m) at an integral multiple of 1/(a power of 2), the division of '1/m' can easily be executed by only bit shift." (EX1006, [0074]; *see also* [0086]

("the pixel interpolation process for enlargement/reduction is realized by multiplication of integers and bit shift, and there is no need to execute a floating point arithmetic operation with a heavy load. Therefore, the non-linear scaling process can be executed by software without causing an increase of the load on the CPU 111.").)

112. Additionally, there would have been a reasonable expectation of success. As I discuss in paragraphs 110 and 111, Obara's non-uniform shifting is not complicated and involves simple equations. Obara also discloses an embodiment where the operation may be even further simplified by executing bit shifts, an operation that is simple and easily performed by a processor including a processor included within a camera. The prior art had on-camera processing capabilities, as Dr. Foroosh admits. The prior art has demonstrated that the processors included within cameras at the time of the '413 patent were capable of processing simple equations. Because the prior art already demonstrated that processors included within cameras had the capability of processing Obara's non-linear scaling math operations and applying its non-uniform shifting, there would have been a reasonable expectation of success.

B. Obara Teaches "determin[ing] a portion within the input image" (Limitations 1[e] And 2[c])

113. As I discuss in paragraphs 12-15, the '413 claims do not require that the "determin[ing] a portion within the input image" be performed after

"obtain[ing] the[/an input] image" and prior to "apply[ing] a transformation." (EX2027, ¶117.)

114. There are multiple passages in Obara that shows that it "determine[s] a portion within the input image," including after obtaining the input image and including prior to applying the transformation. (EX2027, ¶128.) In [0053], Obara describes "[t]he non-linear scaling module 215 vertically divides original image data (A) with, e.g. 720×480 pixels into, e.g. 12 image blocks. The non-linear scaling module 215 horizontally reduces image blocks 6 and 7 which belong to the central area." (EX1006, [0053].) This dividing is a "determ[ing]," the image blocks are "portion[s]," and the original image data is the "input image."

115. [0082] of Obara similarly states "[t]he CPU 111, or the non-linear scaling module 215, divides input image data into a plurality of vertically extending image blocks (block S102), and subjects the input image data to a non-linear scaling process (block S103)." (EX1006, [0082].) The "input image data" refers to the input image that has been obtained. Because it is the input image data itself that is divided (block S102), the "determine" step is performed after obtaining the input image. This is shown in Figure 10, with block S101 (obtaining the input image) being performed before block S102 (determining a portion within the input image). Figure 10 (below) shows block S102 being performed prior to block S103 (applying a transformation). (EX1006, [0082].) Thus, Fleming

teaches "determin[ing] a portion within the input image" including "determin[ing] a portion within the input image" performed after "obtain[ing] the[/an input] image" and prior to "apply[ing] a transformation."

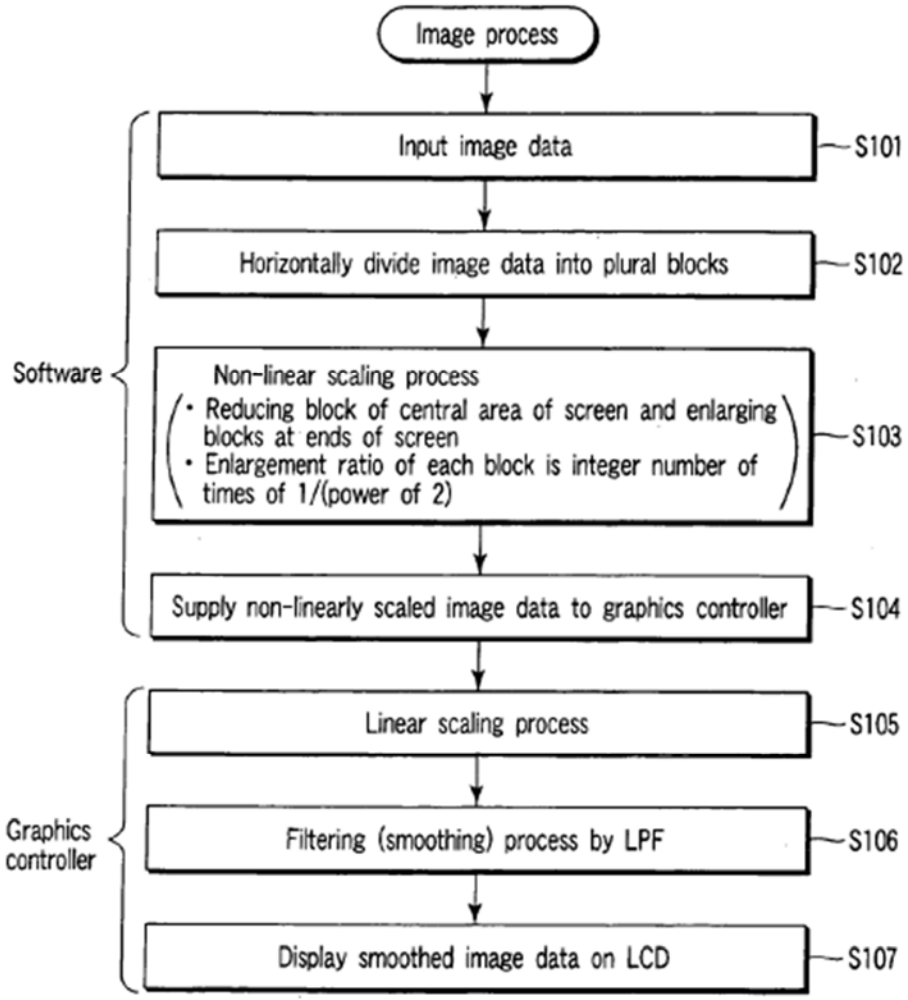


FIG. 10

C. Obara-Liu Teaches Limitations 1[pre]-1[d], 1[f]-1[i], 2[pre]-2[b], 2[d]-2[i], And Claim 7

116. I explained and showed that Obara-Liu teaches limitations 1[pre]-1[d], 1[f]-1[i], 2[pre]-2[b], 2[d]-2[i], and claim 7. (EX1002,¶¶155-162, 166-185,

203-205, 216-221, 223-226.) Dr. Foroosh does not dispute that Obara-Liu teaches limitations 1[pre]-1[d], 1[f]-1[i], 2[pre]-2[b], 2[d]-2[i], and claim 7.

VII. THE OBJECTIVE EVIDENCE DOES NOT SUPPORT NON-OBVIOUSNESS

117. I understand that one of the factual inquiries when determining the obviousness of a patent is to consider objective evidence related to the issue of obviousness, sometimes called "secondary considerations of non-obviousness" or "objective indicia of non-obviousness."

118. I understand objective indicia include: (i) commercial success of a product due to the merits of the claimed invention; (ii) long-felt need for the solution provided by the claimed invention; (iii) unsuccessful attempts by others to find the solution provided by the claimed invention; (iv) copying of the claimed invention by others; (v) unexpected and superior results from the claimed invention; (vi) praise of the claimed invention by others in the art; (vii) independent invention of the claimed invention by others before or at about the same time as it was conceived by the named inventors; (viii) whether others expressed surprise or disbelief regarding the invention; (ix) whether others sought or obtained rights to the claimed invention from the patentee; and (x) whether the inventor proceeded contrary to accepted wisdom in the art.

119. I understand that objective indicia are only relevant to the obviousness inquiry if there is a nexus between the claimed invention and the objective indicia

of non-obviousness. I also understand that a rebuttable presumption of nexus applies only when a patent owner shows that the purported objective indicia evidence is tied to a specific product and that product embodies the claimed invention, and is coextensive with the claims. On the other hand, a patent owner is not entitled to a presumption of nexus if the patented invention is only a component of a commercially successful machine or process. I further understand that to show nexus, any purported objective indicia must be the direct result of the unique characteristics of the claimed invention.

120. I understand that the Board previously found that GoPro failed to show objective indicia of non-obviousness. Based on what GoPro has submitted in its Patent Owner Response and Dr. Foroosh's declarations, I agree with the Board's conclusion.

A. There Is No Nexus

121. GoPro does not argue any presumption of nexus. I understand that a patent owner is not entitled to a presumption of nexus between the evidence and the claimed invention if the patented invention is only a component of a commercially successful product. Mr. Lema admits that SuperView is only a component, or one feature, of HERO7, the allegedly practicing product. (EX2024, ¶¶10 ("HERO7 Black was the first GoPro product to bring the combined HyperSmooth, SuperView, and digital lens package of features for customers

(Horizon Leveling was released 2 years later with HERO9 Black)."), 13 ("HyperSmooth became the 'marquee feature' of HERO7."), 21, 24.) Mr. Lema also admits that the features other than SuperView, like HyperSmooth and Horizon Leveling, were important features in HERO7. (*Id*.)

122. GoPro makes no attempt to show how the purported practicing product, HERO7 (which includes many features other than SuperView), is coextensive with the challenged claims. I understand that the coextensive requirement requires the patent owner to show the product is essentially the claimed invention, but perfect overlap is not necessary. GoPro, however, has failed to do this. There are features in HERO7 other than SuperView, and GoPro has failed to explain the significance of those features and how they impact HERO7. For example, Mr. Lema admits that other "key product features" like HyperSmooth and Horizon Leveling are covered by different patents (i.e., different inventions) and contribute to HERO7's function. (EX2024, ¶¶17, 21 ("In my view, the patented technologies in the '894, '840, '832, and '413 patents were directly responsible for GoPro's sustained commercial success with HERO cameras, especially from the HERO7 onward"), 24 ("While GoPro offers many features and product innovations, the features discussed in this declaration—specifically those associated with the '894, '840, '832, and '413 patents—played a

pivotal role in the commercial and critical success of the HERO7 Black and our HERO camera line more broadly.").)

123. GoPro also does not show that any purported objective indicia is the direct result of the unique characteristics of the claimed invention. In fact, GoPro's own cited evidence shows lack of nexus.

124. For example, GoPro's cited declaration (Ex. 2024) from Pablo Lema shows the contrary. Mr. Lema explained that HERO7 had *many* features, including SuperView. (EX2024, ¶24.)

125. [redacted] (EX2024, ¶16.) [redacted] (*Id*.) [redacted] (*Id*.) [redacted] (*Id*., ¶17.) [redacted] (*Id*.) [redacted] (*Id*., at Exh.

A, .0005 [redacted]

126. [redacted] (EX2024, ¶17.) [redacted] (*Id*., ¶18.) [redacted]

127. [redacted] (EX2024, ¶20.) [redacted] (*Id*.) [redacted] (*Id*. [redacted]

128. Moreover, Mr. Lema's declaration covers four patents directed to three different product features: SuperView, HyperSmooth, and Horizon Leveling. (EX2024, ¶24.)

129. Thus, it my opinion that Mr. Lema's declaration fails to establish that the objective evidence is a "direct result" of SuperView.

B. There Is No Objective Evidence That Supports Non-Obviousness

1. There is no evidence of copying

130. I understand that GoPro's copying evidence is based on the fact that Petitioner's product has a "similar-sounding feature" to SuperView, known as ActionView. But GoPro does not identify evidence showing that the Petitioner had access to GoPro's technology and replicated it.

131. GoPro also does not provide an element-by-element comparison of its product to Petitioner's product. In fact, GoPro's evidence shows that Petitioner's product "is not a 1-1 copy of the GoPro algorithm." (EX2011, 2; *see also* EX2012, 2 ("This is not a 1-1 copy of the GoPro algorithm").)

132. GoPro's evidence that Petitioner did "extensive research" on GoPro's products also fails to show copying. The cited documents merely show that the Petitioner conducted benchmarking and compared its products' performance with GoPro's. Benchmarking is a standard practice in the industry and is not copying, as Mr. Lema concedes. (EX1039, 386:9-14 ("Q. So benchmarking and overtly

copying are different? A. In my opinion, benchmarking something to understand the benefits is very different than reverse-engineering and trying to do exactly what someone else did.").) Mr. Lema also confirmed that GoPro regularly performs teardowns of Insta360 products. (*Id*., 388:24-389:2 ("Q. GoPro also does teardowns of Insta360 products; right? A. I think some people at our company do teardowns of the products that we purchase."), [redacted].)

2. There is no evidence of industry praise

133. GoPro's cited evidence does not show industry praise. For example, there is no showing of how the purported 2019 Consumer Electronics Show award, Emmy award, or "Lucie" award were linked to SuperView. GoPro merely cites the awards were for "its HERO7 Black achievements."

134. The articles GoPro cites also fail to show industry praise because they are directed to GoPro's HERO4 and HERO3+ products, not the HERO7 (the alleged practicing product). For example, EX1040 is a New Atlas article comparing HERO4 to HERO3+. (EX1040, 1 ("Gizmag compares the specs and features of the Black and Silver GoPro Hero3+ and Hero4 cameras.").) Additionally, EX1041 is Little Stuff review of HERO3+. (EX1041, 1 ("Here it is – the GoPro Hero3+ Review from our #GoProAdventures").)

135. GoPro cites anonymous "consumer" inquiries of one competitor that is not associated with Petitioner. (EX2016.) But this is not industry praise. GoPro points to no industry praise of SuperView. Nor do I see any evidence of industry praise.

3. There is no commercial success tied to SuperView

136. GoPro's cited evidence fails to show commercial success. The evidence shows that the purported commercial success is attributed to many factors unrelated to SuperView.

137. [redacted] (EX2018; EX2040; EX2019.) [redacted] (EX2018, 23 [redacted]); EX2040, 10 [redacted]); EX2019, 14 [redacted].)

138. After reviewing the evidence, Insta360's expert Rich Goodin concluded that GoPro's surveys show consumers have "differing purchase motivations." (EX1038, 1342:12-1343:14 ("The surveys don't demonstrate a nexus to the claimed features. All they do is describe differing purchase motivations.").) The evidence cited by Mr. Lema confirms that [redacted] (EX2024, Exh. A, 0007.)

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4. There is no long-felt but unmet need

139. GoPro bases its long-felt need argument on quotations from the ’413 patent. GoPro identifies no other source discussing concerns with traditional aspect ratio conversion methods or expressing a need for new approaches to image aspect ratio conversion.

140. GoPro argues that traditional aspect ratio conversion methods shied away from controlling distortion in an image in the way that SuperView and the ’413 patent do, but that is not the case. Multiple prior art references specifically disclosed aspect ratio conversion techniques that relied on controlling distortion in the same manner and highlighted the benefits of doing so.

141. For example, Fleming discloses: “In one embodiment, the nonlinear functions are such that the original aspect ratio of the video image is preserved near the center region (or strip) of the image and the image is gradually stretched (or compressed) as it is mapped to the edges.” (EX1004, 1:41-45.)

142. As another example, Obara discloses: “Jpn. Pat. Appln. KOKAI Publication No. 2000-148128 discloses an image enlargement process circuit which enlarges image data by non-linear scaling. Using the non-linear scaling, it becomes possible to display image data on the entire wide screen without causing horizontal enlargement distortion of an image of a central area of the image data.” (EX1006, [0006]-[0007].)

143. And Meulen discloses: "The image compression may be applied progressively to the media content that is to be displayed in one or more of the lateral display regions based on the proximity of the lateral display region to the edge of the display." (EX1007, 1:62-65.)

144. Thus, the aspect ratio conversion technique used by SuperView is not unique. It was known years before the patent's priority date.

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* * *

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

Dated: July 14, 2025



Aggelos Katsaggelos

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