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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

GOPRO, INC.,
Patent Owner

Case IPR2024-00984
U.S. Patent No. 10,015,413

**SUPPLEMENTAL DECLARATION OF HASSAN FOROOSH PH.D.
IN SUPPORT OF PATENT OWNER'S RESPONSE**

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1. I have been retained on behalf of GoPro, Inc. (“Patent Owner”) in connection with the above-captioned *inter partes* review (IPR). I have been retained to provide my opinions in support of Patent Owner’s Response. I am being compensated for my time at my standard rate of \$650 per hour. I have no interest in the outcome of this proceeding.

2. In preparing this declaration, I have reviewed and am familiar with the Petition for IPR2024-00984, U.S. Patent No. 10,015,413 (“the ’413 patent”) and its file history, and all other materials cited and discussed in the Petition (including the declaration of Petitioner’s expert Dr. Aggelos Katsaggelos), and cited and discussed in this Declaration. I have also reviewed the Board’s Institution Decision.

3. The statements made herein are based upon my own knowledge and opinion. This Declaration represents only the opinions I have formed to date. I may consider additional documents as they become available or other documents that are necessary to form my opinions. I reserve the right to revise, supplement, or amend my opinions based on new information and on my continuing analysis.

I. QUALIFICATIONS

4. I have been retained to serve as a technical expert in this matter based upon my educational and research experience, and specifically my work in the fields of computer vision, image processing, and optics. My curriculum vitae

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(“CV”) submitted as Exhibit 2002, which contains details about my education, experience, publications, and other qualifications to render an expert opinion in this matter.

5. I am a Professor of Computer Science at the University of Central Florida. My primary research interests include computer vision, image/video processing, and machine learning, including deep learning and large language models.

6. I received my Ph.D. in Computer Science from INRIA (French National Institute for Research on Informatics and Control), University of Nice Sophia Antipolis in 1996. I also earned a Master of Science in Computer Science from the University of Nice Sophia Antipolis in 1993, a Master of Science in Electrical Engineering from Kingston University, U.K., in 1990, and a Bachelor of Science in Electrical Engineering from Kingston University, U.K., in 1989.

7. Prior to research and teaching, I worked as an R&D Engineer at Innovative Engineering Solutions Ltd. in London from 1990 to 1992. Between 1993 and 1996, I served as a Research Assistant in the Scene Analysis and Symbolic Image Processing Group of INRIA, where I performed research in areas such as 3D super-resolution, sub-pixel image registration, and image-based depth and shape recovery and analysis. From 1997 to 2000, I served as an Assistant Research

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Scientist at the University of Maryland, College Park, where I investigated topics such as image registration (2D and 3D), super-resolution of video data for unmanned aerial vehicles, super-resolution of Synthetic Aperture Radar (SAR) and Foliage Penetrating SAR (FOPEN-SAR), and Automatic Target Detection, Tracking, and Recognition (ATD/R). During this time, I authored one of the most cited works on sub-pixel registration and alignment based on phase correlation: (Hassan Foroosh (Shekarforoush), Josiane Zerubia and Marc Berthod, Extension of Phase Correlation to Sub-pixel Registration, IEEE Transactions on Image Processing, vol. 11, Issue 3, pp. 188-200, 2002). Between 2000 to 2002, I served as Senior Research Scientist at the University of California, Berkeley where I also served as the Technical Coordinator and Principal Research Scientist of a Multi-University Research Initiative (MURI) funded by the Office of Naval Research. As part of the project, I conducted research on multi-sensor acquisition of 3D data for autonomous 3D modeling and visualization of urban environments.

8. I joined the Department of Computer Science at the University of Central Florida (UCF) as an Assistant Professor in 2002. Since then, I have served as an Associate Professor, Professor, and CAE Link Professor of Computer Science in the same department. I also served in various other capacities within the department, such as the Graduate Program Coordinator, chair of various leadership

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committees, and most recently in the Faculty Senate Strategic Planning Council for UCF.

9. I have taught a number of courses directed to computer vision and 3D modeling, including 3D Computer Vision, Image Processing, Special Topics in 3D Computer Vision, and Visual Simulation. Since joining UCF, I have also advised and chaired the dissertation of over 30 doctoral students, 28 of whom have already successfully defended their doctoral dissertation, and secured academic positions or industry jobs with major high-tech corporations. As one example, I served as the advisor for a dissertation directed to *“Improving Matching and Classification Through Deep Learning of Structure and Varying Illumination”*. This dissertation involved also working with GoPro camera systems for mobile aerial platforms.

10. I have been the principal investigator or co-principal investigator of numerous research projects funded by the National Science Foundation (NSF), NASA, DoD, and other industry participants, with total funding exceeding \$14M since joining UCF, and ongoing funded projects for additional \$3M. As one related example, I recently served as the principal investigator in two projects funded by the National Science Foundation (NSF) on 3D modeling and camera systems, and the role of 3D information in machine understanding of digitized 3D world.

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11. I have also conducted extensive research in partnership with industry in the field of computer vision, in particular 3D computer vision and camera systems, including body-worn cameras and cameras on agile mobile platforms, or cameras operating in various different modalities (EO, FLIR, polarized, etc.). Below, I highlight some of the projects that were funded by industry and state-sponsored technology transfer initiatives that specifically involved using GoPro camera systems or similar platforms. For example, from 2012 to 2018, I received funding from Jackson Technologies related to Airborne Multisensor Visual Data Processing, which studied automated methods of reconstructing 3D panoramic models around a flying aircraft that used the GoPro camera system and software tools extensively; From 2013 to 2018, I received related funding from the Florida High Tech Corridor (“FHTC”) for Rapid Automated 3D Terrain Modeling from Airborne Data, which similarly studied automated methods of reconstructing 3D models of a terrain from a flying aircraft, again using extensively the GoPro cameras and software tools; From 2008 to 2009, I received funding from Electronic Arts – Tiburon related to Modeling and Tracking Human Activities in Sport Events. The goal of this project was to develop algorithms for tracking and recognition of human activities in sport events, using body-worn cameras similar to GoPro systems, as well as surrounding cameras, network of cell phone cameras, and other sensors.

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12. I have authored or co-authored over 200 articles in peer reviewed journals or conference proceedings, relating to the areas of Computer Vision (CVPR, ICCV, ECCV, etc.), Machine Learning (ICLR, AAAI, ACL, EMNLP, etc.), and Image Processing and Pattern Recognition (ICIP, ICPR). Some related example publications include: Yang Zhang, Zixiang Zhou, Philip David, Xiangyu Yue, Zerong Xi, Boqing Gong, Hassan Foroosh, *PolarNet: An Improved Grid Representation for Online LiDAR Point Clouds Semantic Segmentation*, Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2020; Chuan Sun, Imran Junejo, Marshall Tappen, Hassan Foroosh, *Exploring Sparseness and Self-Similarity for Action Recognition*, IEEE Transactions on Image Processing, vol. 24, issue 8, pp. 2488-2501, 2015; Chen Shu, Luming Liang, Wenzhang Liang, Hassan Foroosh, *3D Pose Tracking with Multi-Templates Warping and SIFT Correspondences*, IEEE Trans. on Circuits and Systems for Video Technology, 2015; Nazim Ashraf, Chuan Sun, and Hassan Foroosh, *View-Invariant Action Recognition Using Projective Depth*, Journal of Computer Vision and Image Understanding (CVIU), vol. 123, pp. 41-52, 2014; Yuping Shen and Hassan Foroosh, *View-invariant Action Recognition from Point Triplets*, IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), vol. 31, no. 10, pp. 1898-1905, 2009; Nazim Ashraf, Yuping Shen, Xiaochun Cao, and Hassan

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Foroosh, *View-Invariant Action recognition using Weighted Fundamental Ratios*, Journal of Computer Vision and Image Understanding (CVIU), vol. 117, pp. 587-602, 2013.

13. Based on my work, I have also applied for and received several patents in the field of image processing, including U.S. Pat. No. 8,755,569 entitled Methods for Recognizing Pose and Action of Articulated Objects with Collection of Planes and Motion, which was issued in 2014.

14. I have served as the editor and/or committee member on numerous professional organizations. For instance, I have been on the editorial board of the IEEE Transactions on Image Processing (Associate Editor, 2003-2008, 2011-2016); IEEE Conference on Computer Vision and Pattern Recognition (CVPR) serving as area chairs, session chairs and Technical Committee member over many years (2004-2012, 2015-2016, 2019-2023); Organizing Committee and sponsorship chair of ACM Multimedia Conference in 2014; and frequent reviewer on various IEEE transactions, including the IEEE Transactions on Pattern Analysis and Machine Intelligence.

15. For my work, I have been honored with numerous awards, including the *Piero Zamperoni Award*, International Association for Pattern Recognition (IAPR) (2004). I have also received several Best Paper awards, including “*The Best*

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Scientific Paper Award” in the IAPR International Conference on Pattern Recognition in 2008, “*The Best Paper Award*” in the IEEE International Conference on Image Processing (ICIP) in 2018, and the *Distinguished Researcher*, UCF College of Engineering and Computer Science (2004-2005, 2005-2006).

16. In sum, I have studied, taught, practiced, and conducted research in the areas of computer vision, image processing, machine learning (deep learning and large language models), and optics.

II. LEGAL UNDERSTANDING**A. The Person of Ordinary Skill in the Art (“POSITA”)**

17. I understand that a person of ordinary skill in the relevant art at the time of the invention (also referred to herein as “ordinary artisan”) is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity—not an automaton.

18. I have been asked to consider the level of ordinary skill in the field that someone would have had at the time the claimed invention was made. In deciding the level of ordinary skill, I considered the following:

- the levels of education and experience of persons working in the field;
- the types of problems encountered in the field; and
- the sophistication of the technology.

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19. I have reviewed the declaration of Dr. Katsaggelos, including his opinions regarding the Person of Ordinary Skill in the Art, which is a person with “a bachelor’s degree in engineering or computer science, or equivalent field, and two years of experience working on image or video processing, or digital cameras” or alternatively “four years of experience working on image or video processing, or digital cameras.” Ex. 1002, ¶33.

20. My opinions set forth in this Declaration apply Dr. Katsaggelos’s definition of a POSITA.

21. I am well-qualified to determine the level of ordinary skill in the art. I was a person of at least ordinary skill in the art at the time of the priority date of the ’413 patent under Dr. Katsaggelos’s definition of a POSITA. If I do not explicitly state that my statements below are based on this timeframe, all of my statements are to be understood as an ordinary artisan would have understood something as of the priority date of the ’413 patent.

B. Legal Principles

22. I am not a lawyer and will not provide any legal opinions. Though I am not a lawyer, I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

PUBLIC VERSION1. Anticipation

23. I understand that to obtain a patent, a claimed invention must have, as of the priority date, been novel. I understand that to prove that a prior art reference anticipates a patent, the four corners of the prior art reference must describe element of the claimed invention, either expressly or inherently. I also understand that the prior art reference must describe the elements arranged as in the claim and that it is improper to combine disparate embodiments to establish anticipation unless a POSITA when reading the reference could at once envisage such a combination.

2. Obviousness

24. I understand that to obtain a patent, a claimed invention must also have, as of the priority date, been nonobvious in view of prior art in the field. I understand that an invention is obvious when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art.

25. I understand that to prove that prior art, or a combination of prior art, renders a patent obvious, it is necessary to: (1) identify the particular references that singly, or in combination, make the patent obvious; (2) specifically identify which elements of the patent claim appear in each of the asserted references; and (3) explain how the prior art references could have been combined to create the inventions

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claimed in the asserted claim, including how there would have been a reasonable expectation of success.

26. I understand that a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art, and that obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention.

27. I also understand that a reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant. Even if a reference is not found to teach away, I understand its statements regarding preferences are relevant to a finding regarding whether a skilled artisan would be motivated to combine that reference with another reference.

3. *My Understanding of Claim Construction Law*

28. I have been informed that patent claims are construed from the viewpoint of a person of an ordinary artisan and that patent claims generally should be understood consistent with their ordinary and customary meaning at the time of the invention. A review of the patent claim language, the patent specification, and

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its prosecution history are also necessary to determine the proper meaning and scope of the term at issue.

29. I have further been informed that in the specification and prosecution history the patentee may define a claim term in a way that differs from the ordinary and customary meaning. I understand that during prosecution of the patent before the U.S. Patent and Trademark Office, the Applicant may make representations or provide definitions of terms that may affect the scope of the patent claims. In particular, the Applicant may, during the course of prosecution, limit the scope of the claims to overcome prior art and/or disavow claim coverage by making clear and unambiguous statements to that effect.

30. I have been informed that an ordinary artisan may, among other things, consider dictionaries, publications, other patents, and treatises (*i.e.*, “extrinsic evidence”). I understand that extrinsic evidence may generally not be relied on if it contradicts the meaning of claim language provided by the intrinsic evidence, such as express definitions given for terms in the specification.

4. *Secondary Considerations of Non-Obviousness*

31. 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

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“objective indicia of non-obviousness.” I understand that such evidence can often be probative of the issues of obviousness.

32. I understand that examples of objective evidence include (1) commercial success, (2) copying, (3) industry praise, (4) skepticism, (5) long-felt but unsolved need, and (6) failure of others.

33. I understand that there must be a nexus between the patented invention and the evidence of secondary considerations. I further understand that there is a presumption of such a nexus if the claims of the patent are coextensive with a product or products that are the subject of the secondary considerations evidence. I further understand that in order for a claim to be coextensive with a product, one must look at the claims at the whole and not just the new claimed feature. In addition, the claimed invention should not be merely a subcomponent of the products sold but should encompass the entire apparatus.

III. CLAIM CONSTRUCTION

34. In my opinion, all claim terms should be given their ordinary and customary meaning in light of the specification.

IV. SUMMARY OF THE '413 PATENT

35. The '413 patent is directed to a camera that takes an image from an image sensor and converts its aspect ratio for display on the camera. The aspect ratio conversion involves “non-linearly warp[ing the image] relative to the input

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image such that a distortion in the output image relative to the input image is greater in a corner region of the output image than a center region of the output image.” Ex. 1001, Abstract. This proves better than merely removing content (*e.g.* cropping), causing undesirable distortion (*e.g.* linear transformations), or not fully using the display screen (*e.g.* padding or black bars). *Id.*, 1:6-25.

36. Figure 2A illustrates the aspect ratio conversion, which describes that “an input image is obtained” from an image sensor, after which the center portion of the image “is ***chosen*** to be the region of interest that is most fully corrected and the distortion increases in each direction as the frame boundary is approached.” Ex. 1001, 3:63-64, 4:19-22. By choosing the region of interest that will be less-distorted, this allows the portion to “dynamically change between images” in order to “follow a moving object.” Ex. 1001, 4:32-36.

37. The ’413 patent also describes that the transformation uses non-uniform pixel shifting, *i.e.* a non-linear transformation. Ex. 1001, Abstract (“[T]he output image is ***non-linearly*** warped relative to the input image”); Ex. 1001, 3:61-4:13. The pixel-shifting is based on the specific horizontal and vertical positions of the pixel. For example, the patent describes using sixth-order polynomials to calculate how much horizontal and vertical shift to use. For the horizontal shift, the patent provides the below exemplary equation. Ex. 1001, 6:65-7:5.

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$$\Delta h/H = 0.1107h^6 + 0.534h^5 - 1.7813h^4 + 1.3167h^3 - 0.0722h^2 - 0.1073h$$

38. For the vertical shift, the patent provides similar equations, although provides a different equation for each decile portion of the image. *Id.*, 7:5-43. For example, the below vertical-shift equation is used for the first 10% of the image:

$$\Delta v/V_0 = -0.0749v^6 - 0.3167v^5 + 1.0939v^4 - 0.8113v^3 + 0.0408v^2 + 0.0678v$$

A. Prosecution History

39. Below I provide a summary of the prosecution history of the '413 patent.

40. Prior to any office action, the '413 patent's claims read similarly to the allowed claims, with the notable exception that instead of reciting the step of "determin[ing] a portion within the input image, the portion including a subset of the pixels," the claim instead recited that "the input image includes a portion including a subset of the pixels." Ex. 1003, 135-36. In this set of claims, the claimed "portion" was still required to have less pixel shift than pixels outside of the portion. *Id.*

41. The examiner issued a single rejection, that the claims were obvious over U.S. Pat. 8,218, 895 ("Gleicher") in view of U.S. Pat. No. 7,496,243 ("Oosawa"). Ex. 1003, 46-50. The examiner stated that while Glecher did not

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show non-uniform pixel shifting, Oosawa “teaches an image display apparatus and method wherein the amount of shift ... is smaller in the center of the image than in the peripheral of the image.” *Id.* at 48.

42. After this rejection, the applicant amended the independent claims to the current claims, specifically adding the step of “determin[ing] a portion within the input image, the portion including a subset of the pixels,” and removing the language that “the input image includes a portion including a subset of the pixels.” Ex. 1003, 32. The applicant then argued that, while Oosawaga may “show[] the amount of shifting to be applied to the center of the image is smaller than the peripheral of the image,” it does not disclose “determining a portion (including a subset of pixels) within an input image and non-uniformly shifting the pixels of the input image such that differences between input positions and output positions are less for the subset of the pixels than other pixels of the input image.” Ex. 1003, 39.

43. The examiner allowed the claims after this amendment. Ex. 1003, 13.

B. The Challenged Claims

44. I understand that Patent Owner has disclaimed all claims except claims 1, 6, and 7. Claims 6 and 7 depend on claim 2, so I will address Petitioner’s contentions against claim 2 as well. However, as a result of this disclaimer,

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Petitioner's Ground 2 challenge (which only addresses disclaimed claims) need not be addressed.

V. GROUND 4: MEULEN IN VIEW OF CHAO

45. I begin with Ground 4, as that is the ground that the Board agreed with Petitioner.

46. Below is a summary of the Meulen and Chao.

A. Summary of the Prior Art**1. Meulen**

47. Meulen describes a “wireless device” such as a Palm Treo depicted in Figure 1 that receives an image from a “media source” and converts its aspect ratio to fit on the device’s display. Ex. 1007, Abstract. Meulen’s device contains a camera, but Meulen does not explain what it does with that camera. Instead, the images that are converted come from an external “media source,” such as a “computer,” “web server,” “DVD device,” or even an external “digital camera.” *Id.*, 3:53-67.

48. The aspect ratio conversion described in Meulen is a piece-wise linear transformation where certain pre-specified regions are compressed at pre-designated ratios. Table 1 provides one specific implementation of this conversion, where the portion covering the middle 200 horizontal pixels are not

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compressed, whereas the first and last portions of 10 horizontal pixels are compressed at a “4:1” ratio. Ex. 1007, 6:4-37.

TABLE 1

	Region					Total
	1	2	3	4	5	
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

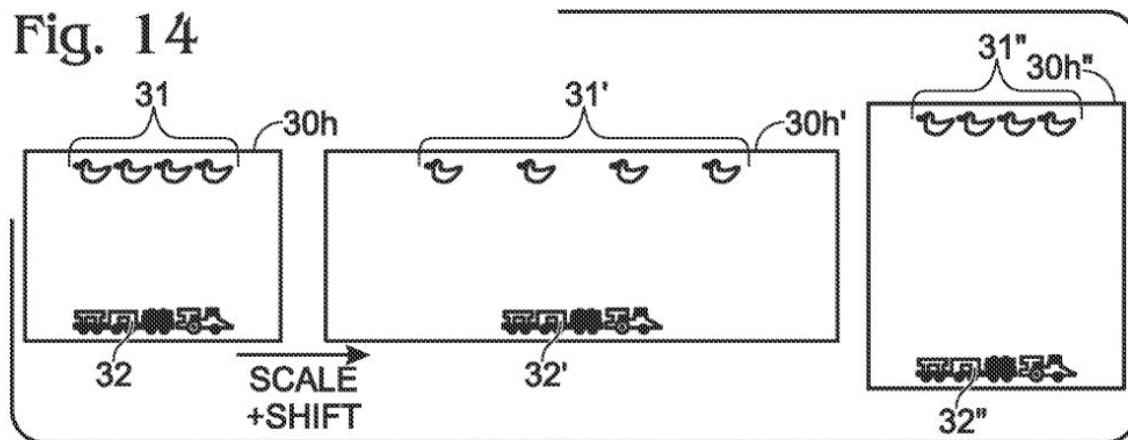
49. Meulen describes that compression uses “polyphase filters arranged to sample a line of source pixels and to generate a compressed and/or scaled line of display pixels based on a compression factor.” Ex. 1007, 5:19-23. Polyphase filters are known to take a group of pixels and average them into a single pixel.

2. Chao

50. Chao is directed to resizing documents that are intended to be printed on different sizes of paper. Ex. 1008, Abstract. Chao is concerned with how graphical design elements such as a pre-designed “border” on a greeting card or added to a photo can be distorted if the image is printed to paper that does not match the size of the original image. Ex. 1008, ¶1 (“For example, people frequently like to incorporate professionally designed borders in their photos, newsletters, postcards, greeting cards and the like.”). Chao therefore introduces a

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method of separating foreground objects (*e.g.* graphic art found within the border added to a photo) from background objects (*e.g.* the original photo), stretching/resizing the background elements to the new aspect ratio, and then scaling and/or shifting the foreground objects to a new position while maintaining their aspect ratio. For example, Figure 14 shows how image 30h is altered to either image 30h' or 30h''. Ex. 1008, ¶91. The ducks and trains (foreground elements) remain “the same size” and shape but are shifted to new locations to maintain their relative spacing across the entire sheet. *Id.*



51. In other examples, the foreground images are uniformly scaled, but maintain the same aspect ratio.

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52. In my opinion, Meulen does not disclose that the “input image” comes from the embedded camera or input sensor.

53. The claims recite that the aspect ratio transformation is applied to an “input image.” In Claim 1, the “input image” comes from the “image sensor” of the “image capture apparatus” that performs the transformation. In Claim 2, all of the claimed steps are performed by “physical processors,” which claim 6 recites must reside in a “camera.” Thus, a POSITA would understand that the “input image” comes from the image sensor of that camera.

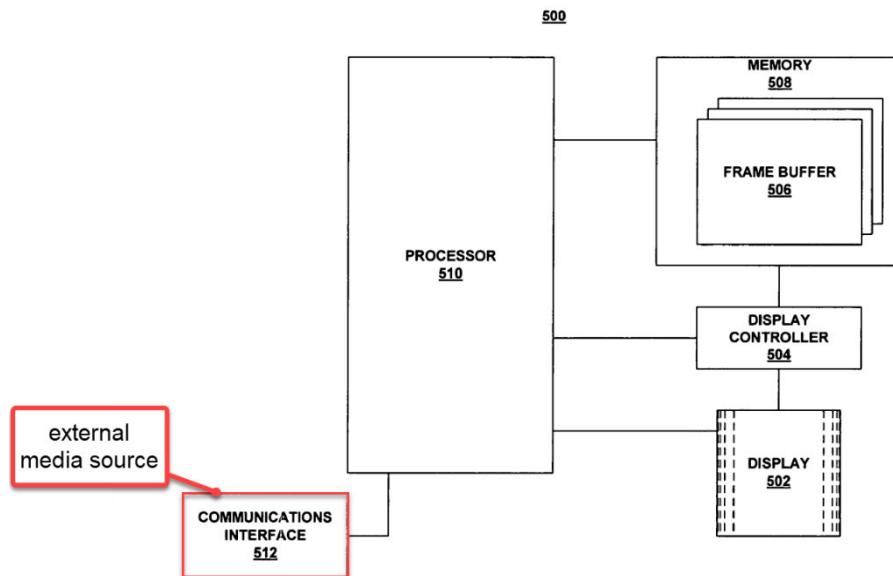
54. Petitioner maps the claimed apparatus and system to Meulen’s “mobile device,” and the “input image” to Meulen’s “media source content.” Pet. 87. However, Meulen never discloses that its wireless device obtains “media source content” from the device’s embedded camera or image sensor. Instead, Meulen is clear that the “media source content” comes from an external source.

55. That is, in fact, the understanding of what a “media source” is—an external source for media content. Meulen’s description of a “media source” is in line with this understanding: “any source capable of *delivering* media source content to the wireless device 100.” Ex. 1007, 3:51-53 (emphasis added). Because

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the content is ***delivered*** to the wireless device, it comes from an external source, not from an embedded image sensor. An embedded camera or image sensor does not ***deliver*** content to the device, as it is already contained on the device when captured. Thus, all of the examples in Meulen of a media source are external media sources: “a computer,” “server,” “web server,” “television signals,” “DVD device,” “VHS[] device,” “digital camera,” “video camera,” “portable media player,” and “gaming device.” *Id.*, 3:53-67.

56. Meulen’s description of its device also is consistent with this understanding. Media source content is received via an interface for external sources, such as “cellular data systems” like “GSM” and “EDGE.” *Id.*, 4:1-12. As shown in Figure 5, Meulen describes that the “media source content” is received “through a communications interface 512,” which couples the device to a network or a network device, *i.e.* an external source. *Id.*, 13:6-11. I note that Dr. Katsaggelos agrees that the “communications interfaces ... always impl[ies] external source.” Ex. 2026, 18:8-16.

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57. Meulen does describe that its wireless has a “digital camera.” Ex. 1007, 1:6-9. But Meulen does not describe that it ever processes images from that camera. Meulen does not even describe that the camera outputs images with a different aspect ratio than the display of its device. Thus, it would not be obvious to a POSITA to apply non-uniform transformations as required by the claims (or even the piece-wise linear transformation described by Meulen) to any images captured by the device’s embedded camera. Non-uniform transformations were complex operations that were performed off the camera using specialized post-processing devices and software, as shown for example in Fleming and Obara. Given the lack of disclosure in Meulen of differences in aspect ratio between the device’s image sensor and its display, there is no need in Meulen to perform any

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aspect ratio conversion. This is further reinforced by the fact that Meulen’s examples of external media sources typically have aspect ratios that are not 1:1, such as “standard television,” “web sites,” “multimedia products,” HDTV,” “digital video cameras,” and “DVD[] players.” Ex. 1007, 1:16-25.

58. Even assuming there is a mismatch between the display screen and an image sensor of Meulen’s device, conventional camera applications for mobile devices like those described in Meulen used much simpler, alternative techniques for dealing with the aspect ratio issue such as cropping, padding, or linear scaling. *Id.*, 1:11-13. These techniques were considered sufficient for previewing content on mobile devices at the relevant time. It was not obvious in August of 2013 for a mobile device to apply the complex, non-uniform transformations to digital images captured by an embedded camera of the device itself.

C. Limitation 1[e]/2[c]: Meulen Does Not Disclose “Determin[ing] a Portion Within the Input Image”

59. The claims require “determin[ing] a portion within the input image, the portion including a subset of the pixels” *after* obtaining the input image but *prior* to the aspect ratio transformation. This is because this “determining” step uses the term “the input image” which has an antecedent basis to the “input image” that was obtained in the previous step. And this “determining” step further defines the “portion” that is the antecedent basis for the “portion” that is used in the

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transformation step. These steps are different operations, which Dr. Katsaggelos agrees. Ex. 2026, 26:21-23. As I discussed above, this step was added during prosecution to overcome the prior art merely disclosed an image containing such a portion after a transformation was complete.

60. For this ground (as well as the other grounds), Petitioner does not explain how the prior art “determine[s] a portion.” Instead, the Petition simply quotes the prior art’s description of the result of the transformation having a portion that is less distorted relative to other portions. For example, for Ground 4, I provide the Petition’s entire analysis:

“[C]entral 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.) A POSITA would have understood that the central region within the media source content has a corresponding central display region, which includes a subset of the source pixels. (EX1002, ¶¶252-253.)

Pet. 88.

61. There is no explanation here of how meets the limitation of determining a portion, nor is there an explanation of how that step is performed after obtaining the input image and before a transformation is applied. Without such an explanation, Petitioner’s argument is that a less distorted “portion” is

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determined by merely applying a different compression to different portions of an image. This would fail to give meaning to the “determining” step.

62. I note that the ’413 patent provides clear examples of “determining a portion.” For example, in Figure 2A, “an input image is obtained,” after which the center portion of the image “is *chosen* to be the region of interest that is most fully corrected and the distortion increases in each direction as the frame boundary is approached.” Ex. 1001, 3:63-64, 4:19-22. In addition, the portion “may dynamically change between images” in order to “follow a moving object.” Ex. 1001, 4:32-36. These determinations are performed after the image is obtained.

63. Another example would be a user-selected mode. A user-selected mode can configure a warping function (which is later applied to the image) so that less distortion occurs in a center portion, such as in GoPro’s commercial embodiments which allow a user to select between different modes (*e.g.*, Superview or Wide view) that results in a warping grid that determines different less distorted portions when applied to the image. ’413 patent at Abstract (“In one embodiment, the output image is non-linearly warped relative to the input image such that a distortion in the output image relative to the input image is greater in a corner region of the output image than a center region of the output image.”), 2:15-20 (same).

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64. A POSITA would have understood that the various embodiments in Meulen describe *pre-assigned* portions with *pre-assigned* compression ratios. After all, Meulen describes these tables as different “implementations” of its algorithm, as opposed to different choices that a user or system determines. Ex. 1007, 5:31-37. I note that Dr. Katsaggelos agreed that the compression ratios are pre-assigned and that Tables 1-4 are separate embodiments. Ex. 2026, 20:18-22, 23:3-6.

65. I further note that Dr. Katsaggelos described the different implementations in Meulen as a “designer’s choice” determined by “the person who implement[s]” the system. Ex. 2026, 22:24-23:17. I agree with that characterization. In Meulen, the particular portions and their respective compression ratios are decided in advance and then implemented into the system. When the input image is delivered to device from the media source, the device simply executes the chosen algorithm with its pre-assigned portions and ratios. There is no separate step of determining the portion after the image is received.

66. In my opinion, Dr. Katsaggelos’s understanding of the limitations is based on a flawed premise that the “determining” step and “transformation” step can be described as “integral” or “intertwined.” Ex. 2002, 30:24-31:8. He described that these two separate steps can instead be “all done in one step.” *Id.*,

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28:15-23. When asked if non-uniform shifting of pixels would “necessarily determine a portion,” he confirmed that “the transformation [step] does both determining the portion and resulting in non-uniform shifts of the pixels” and that “[t]he transformation is the glue that makes everything happen here.” Ex. 2026, 30:2-18. Based on this testimony, I conclude that Dr. Katsaggelos believes by merely applying a non-uniform transformation, the “determining” step is inherently and necessarily performed. In my opinion, such a view fails to give meaning to the “determining” step, which must be a separate step between obtaining the image and applying the transformation.

67. I therefore disagree with the Board’s conclusion that “[b]y identifying a central region of 200 pixels, Meulen determines a portion of the input image.” ID, 16. Meulen does not describe that it “identifies a central region” after obtaining the image but before applying the transformation. As I discussed above, the central region is predetermined by the designer.

D. Limitation 1[g]/2[e]: Meulen Does Not Disclose “Non-Uniform” Transformation

68. In my opinion, Meulen does not disclose the claimed non-uniform transformation, because such a transformation must be a non-linear transformation as described in the ’413 patent. Ex. 1001, Abstract (“[T]he output image is *non-linearly* warped relative to the input image”). I understand that Dr. Katsaggelos

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agrees with this requirement. Ex. 2026, 34:7-13 (agreeing that “non-uniform shifting ... need[s] to apply a non-linear transformation”).

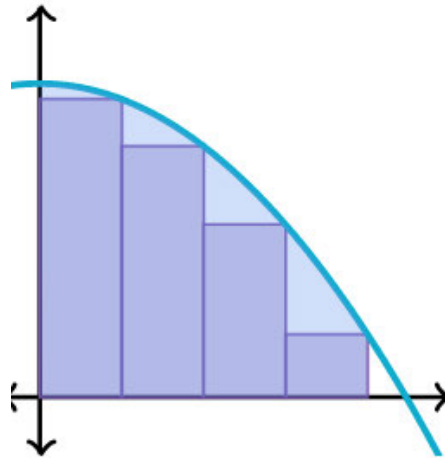
69. The requirement of a non-linear transformation is further supported by the '413 patent's specification, which describes the invention as an improvement over conventional linear scaling techniques which “introduce[d] perceivable distortion into the image.” Ex. 1001, 1:12-18. And, the embodiment described by reference to Figures 2A and 2B distinguishes between a “linear scaling function” and a “non-linear warping process,” teaching that this example of “non-uniform” pixel shifting involves both. Ex. 1001, 3:61-4:13.

70. In my opinion, Meulen fails to meet this limitation because it does not disclose a non-linear transformation. Instead, Meulen describes a piece-wise linear transformation that can only approximate a non-linear transformation by using multiple linear transformations.

71. A piece-wise linear transformation is different from a non-linear transformation. It involves estimating a non-linear transformation by simplifying it to several linear transformations. It can be analogized to estimating a curve by using several straight lines. A classic example is using multiple rectangles to find the area under a curve. Instead of performing a non-linear calculation, the area is divided into multiple rectangles whose areas are significantly easier to calculate

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using a linear calculation (*i.e.* height * width). Since there are multiple rectangles, this constitutes a piece-wise linear transformation.



72. Meulen’s algorithm is a piece-wise linear transformation. It involves applying linear compression ratios to each vertical partitions of an image, such as reflected in Meulen’s Table 1. This is in order to approximate a non-linear transformation, such as the one performed by GoPro’s cameras or described in the ’413 patent, where each pixel is shifted a specific amount based on its x-y position and no pixel is shifted in the same way. The reason why the approximation is chosen is because piece-wise linear transformations can be performed much more quickly than non-linear transformations. As Dr. Katsaggelos described it, piece-wise linear transformations are computationally “indistinguishable” to a linear transformation. Ex. 2026, 40:19-41:8.

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73. On the other hand, non-linear transformations are generally complex, making them difficult to calculate and computationally expensive to implement.

Ex. 2026, 40:1-7 (agreeing that linear approximations are used to “avoid the complexities of a non-linear calculation”); 38:23-39:3 (“[I]f it’s an extremely complicated non-linear function, it might take longer to implement.”). For example, the ’413 patent describes such non-linear transformations. The below sixth-order equation is the horizontal shift based on h , the horizontal position of the pixel. Ex. 1001, 6:65-7:5.

$$\Delta h/H = 0.1107h^6 + 0.534h^5 - 1.7813h^4 + 1.3167h^3 - 0.0722h^2 - 0.1073h$$

74. A similar sixth-order equation is used for the vertical shift. Ex. 1001, 7:6-42.

75. These equations are a non-linear transformation because they apply to **every** pixel and affect the shift of each individual pixel based on their specific horizontal and vertical position. No two pixels will have the same amount of shift. But it was not known to use such equations in a portable device, because implementing them is computationally expensive, and even calculating the optimal sixth-order polynomial for pixel shifting is also complicated and expensive.

76. I understand that Dr. Katsaggelos opined that piece-wise linear transformations are nevertheless non-linear transformations, since they

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approximate non-linear transformations. Ex. 2026, 38:11-18. I disagree. There are key differences between the two. The former merely approximates the latter by using multiple linear transformations. As a result, piece-wise linear transformations are “computationally indistinguishable” from linear transformations. Ex. 2026, 40:19-41:8. Indeed, the very reason to use piece-wise linear transformations is because they “avoid the complexities of a non-linear calculation.” Ex. 2026, 40:1-7.

E. Limitation 1[g]/2[e]: The Combination of Meulen and Chao Does Not Render Obvious Pixel Shifting

77. In my opinion, neither Meulen or Chao describe pixel shifting (much less non-uniform pixel shifting), and Petitioner’s proposed combination likewise does not teach non-uniform pixel shifting.

1. *Meulen Alone Does Not Disclose Pixel Shifting*

78. In my opinion, Meulen’s compression is not pixel shifting. Shifting involves moving pixels. The ’413 patent makes this clear, where pixel-shifting is described as “an **example** of a ... warping function.” Ex. 1001, 5:28-64 (“[P]ixels on the left half of the image **shifting** to the right”). The ’413 patent explains that a pixel is shifted by using a “horizontal distortion **offset**” where “a point in image **moves** in a direction away from the reference edge divided by the image size H.”

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Id., 5:43-47. The sixth-order polynomials I described above involve pixel offsets, *i.e.* moving of pixels.

79. Dr. Katsaggelos appears to agree that pixel shifting means moving pixels. Ex. 1002, ¶262 (“shifting the pixels from the input positions to the output positions”); Ex. 2026, 80:8-12 (“Shift is a common word. Maybe it’s like **moving** something from one place to another [such as] [p]ixels or objects, foreground objects.”). A method for performing pixel shifting to reduce the number of pixels in an image would, for example, need to algorithmically decide which pixel is shifted, and which pixels are not, and the amount of the offset.

80. In my opinion, Meulen does not describe that its image compression or scaling involves **moving** pixels from one position to another. Instead, Meulen describes that its compression or scaling involves multiple “source pixels” compressed into a smaller number of “display pixels.” Ex. 1007, 6:27-36 (“The lateral display regions 140-1 and 140-5 each may comprise 10 pixels and subject media source content to a 4:1 image compression ratio (e.g., **40 source pixels to 10 display pixels**).”); 7:46-65; 8:12-47; 9:31-10:6.

81. Meulen describes that the compression is performed using “polyphase filters arranged to sample a line of source pixels and to generate a compressed and/or scaled line of display pixels based on a compression factor.” Ex. 1007,

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5:19-23. A polyphase filter involves combining a number of pixels into one pixel using multiple phases that can be reused for subsequent pixels. Thus, rather than shift pixels, Meulen’s polyphase filters is better characterized as blending multiple pixels into one pixel.

82. I note that Petitioner does not even assert that Meulen discloses pixel shifting. They appear to agree that it does not, which is why Petitioner relies on the combination of Meulen and Chao. Pet. 91 (“Meulen mentions scaling, but does not disclose the details of how to perform scaling. To the extent that Meulen does not teach shifting pixel positions, it would have been obvious.”).

2. *Chao Does Not Disclose Non-Uniform Pixel Shifting*

83. In my opinion, Chao does not disclose non-uniform pixel shifting. The only “shifting” that is described in Chao is the shifting of graphical objects (*e.g.* clip art or icons) to be rearranged on an image, but not that they are shifted non-uniformally.

84. Petitioner relies on Chao’s disclosure that a “**background** element [of an image] is re-sized by stretching or shrinking” which “mean[s] the resizing of an element without regard to the original aspect ratio of the image.” Pet. 91-92 (quoting Ex. 1008, ¶¶28, 63). Petitioner then asserts that “[a] POSITA would understand that stretching/shrinking means shifting the pixels’ positions.” Pet. 92.

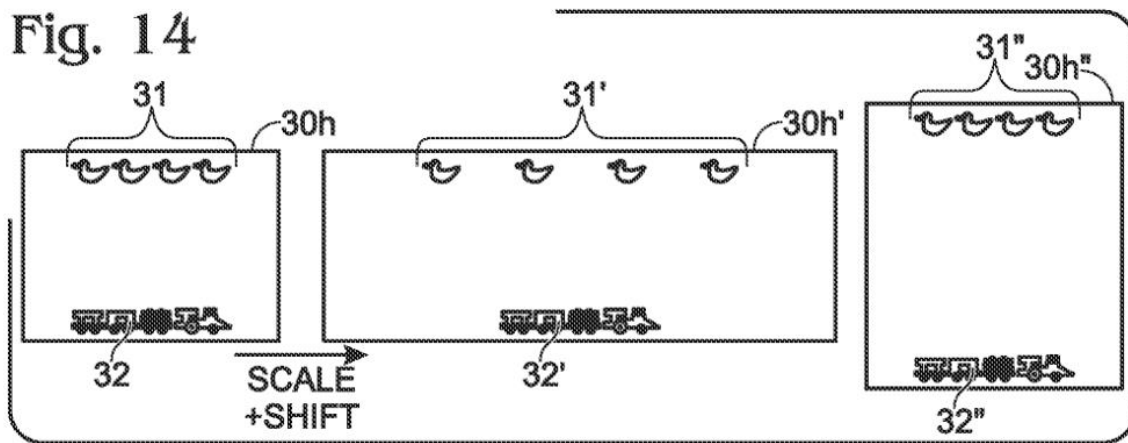
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85. However, Chao never describes that stretching/shrinking involves shifting pixels, *i.e.* moving pixels from one position to a new position as opposed to adding/subtracting pixels through an interpolation or compression process. Dr. Katsaggelos merely asserts that “[a] POSITA would have understood that stretching/shrinking means shifting the pixels positions to achieve a different size (resizing).” But Chao does not describe any such “shifting” of “pixel positions,” and resizing could be performed by, for example, the pixel blending described in Meulen.

86. The only “shifting” Chao describes is the shifting of ***foreground*** objects in conjunction with the stretching of the background. For example, Figure 14 states that the transformation from image 31 to image 31’ or alternatively image 31’’ involves a “SCALE + SHIFT.” Chao’s specification explains that the foreground duck and train objects are “the same size” but are instead moved (*i.e.* shifted) to a different location. Ex. 1008, ¶91. This shifting is of entire ***objects*** (*e.g.* the ducks), and does not teach or suggest non-uniform ***pixel*** shifting, as claimed.

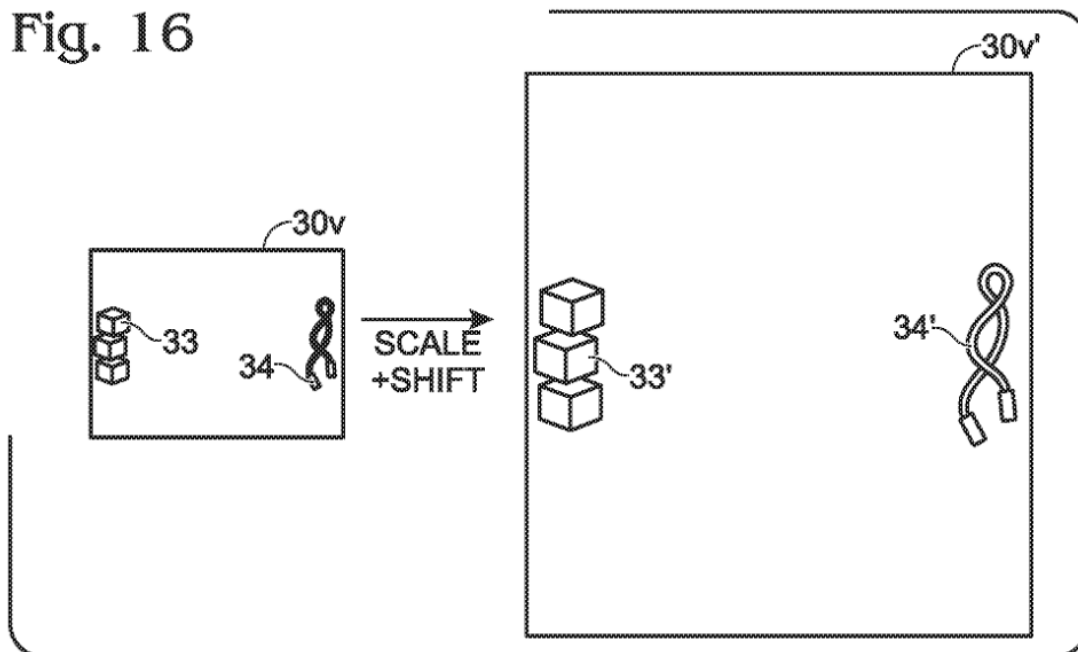
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Fig. 14



87. In another example from Figure 16, the foreground objects 33' and 34' (the cubes and jump rope) are “scaled by a factor of 2x ... while maintaining the original aspect ratio” and then “repositioned.” Ex. 1008, ¶94. Again, such scaling and shifting does not involve non-uniform pixel shifting. The foreground objects are uniformly shifted.

Fig. 16



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88. Specifically, foreground objects are modified using “a uniform scaling factor along both the horizontal and vertical direction” such that the objects’ “aspect ratio ... may be **preserved**.” Ex. 1008, ¶93. Indeed, the entire purpose of using a uniform scaling factor and then repositioning is to avoid distortion of the foreground objects that occurred in prior art methods that changed the aspect ratio of the image. *Id.*, ¶2 (“As shown, the ducks that are used as upper border elements 31 have been stretched to fit the width of the image size, **distorting the original proportions** and overall look of the ducks.”). Such scaling and shifting is not applicable to the compression methods of Meulen used for **changing** the aspect ratio.

3. *No Rationale to Combine*

89. In my opinion, a POSITA would not be motivated to combine Meulen and Chao.

90. A POSITA would not have looked to Chao to modify Meulen, because they address very different problems. Meulen is concerned with modifying content from a media source to be displayed on a device’s screen. Chao, by contrast, is directed to changing the aspect ratio of a document intended for printing.

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91. Meulen’s compression is intended to avoid “black bar[s] on square displays” when viewing media source content on a display with a different aspect ratio. Ex. 1006, 1:26-29. Thus, the system is predesigned to compress the media content in a way that avoids distortion near the middle where the user’s focus is more likely to be placed.

92. On the other hand, Chao is directed to graphical design, *i.e.* “professionally designed **borders** in [] photos, newsletters, postcards, greeting cards and the like.” Ex. 1008, ¶1. Chao discloses a graphical design solution aimed at avoiding distortion of **stylized borders** applied to a document that may be printed on differently-sized pages. This is why Chao uses a method for separating foreground objects from background objects. While this method makes sense for graphically designed borders that have usable metadata or discrete, pixel-defined elements (Ex. 1008, ¶25), it is not a suitable approach for resizing and shifting media source content elements for display on a mobile device like Meulen.

93. In my opinion, Chao’s approach is also incompatible with Meulen because it involves stretching/shrinking **only** the background and uniformly scaling and shifting entire foreground objects to be arranged in a stylized way suitable for graphic design. For example, in Figure 14, Chao describes that for modified image 30h’, “the ducks are the **same size** as the ducks on page 30h, but have been spread

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out so that the ducks on page 30h' occupy the same relative space as the ducks on page 30 h." Ex. 1008, ¶91. Having the ducks "occupy the same relative space" between images is a **graphic design** concern, not a concern for adapting externally derived media source content (such as video from a DVD) for display on a fixed-size screen as taught by Meulen. It would simply not make sense for a system like Meulen to try to separate media source content elements and apply different transformations—preserving spacing between some, while imposing distortions on others—where there may be no meaningful way to distinguish between those elements.

F. Limitation 1[g]/2[e]: Meulen Does Not Disclose Non-Uniform Pixel Shifting Based On the Pixel's Position on the Horizontal and Vertical Axes

94. In my opinion, Meulen does not disclose that its compression algorithm is based on both the horizontal and vertical position.

95. The Challenged Claims require non-uniform pixel shifting that is "based on (1) the input positions along the first axis, and (2) the input positions along the second axis." In other words, the amount of non-uniform pixel shift must be based on the horizontal and vertical position of the pixel, requiring non-uniform pixel shifting for both directions.

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96. As I discussed above, Meulen does not disclose pixel shifting, nor that it is non-uniform (*i.e.* non-linear transformation). However, assuming that Meulen's compression is non-uniform pixel shifting, it still fails to meet the claims because it is not applied both horizontally and vertically.

97. In the various embodiments described by Meulen, its compression ratio only changes in the horizontal direction, not the vertical direction. For example, in Table 1, each region is a vertical partition "defined by the 320 horizontal pixels of the display," and therefore each region's compression ratio is only affected by the horizontal position of that region. Ex. 1007, 5:65-67. Thus, as confirmed by Dr. Katsaggelos, the compression ratio changes in a step-wise fashion "in the horizontal direction only." Ex. 2026, 47:3-13. But in the vertical direction, "the compression ratio ... would stay the same" for a pixel no matter where it is located in the vertical direction. Ex. 2026, 47:14-22.

98. The Petition does not explain how Meulen meets this limitation that requires non-uniform pixel shifting based on both horizontal and vertical positions. The Petition does, however, merely quote (without explanation) Meulen's disclosure that "image compression and/or scaling may be applied in a horizontal direction and/or in a vertical direction." Pet. 91 (quoting Ex. 1007, 10:19-26).

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99. But Meulen does not disclose that the compression in the vertical direction is performed non-uniformly. A POSITA recognizes that this cited passage from Meulen merely describes the possibility of applying the previously disclosed piecewise linear horizontal compression followed by a ***uniform*** vertical scaling. Indeed, Meulen makes clear that if compression is “applied in both the horizontal and vertical direction,” it is still only using the horizontally-aligned “lateral display regions 202-1-4 and 202-6-9.” Ex. 1007, 10:21-26.

100. By contrast, the ’413 patent provides an example in Figure 2A where non-linear warping occurs on both axes. Ex. 1001, 4:9-13 (“[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.”). Figure 2A, which is described by language tracking the claim language, clearly shows non-linear warping of the circles based upon their input horizontal and vertical positions. And the sixth-order polynomials I discussed above also involve non-uniform shifting based on horizontal and vertical positions.

VI. THE REMAINING GROUNDS

101. I am aware that the Board found that, for Grounds 1 and 3, Petitioner did not prove patentability. In my opinion, the Board correctly concluded that

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“Petitioner does not appear to rely on any evidence in Grounds 1 and 3, other than [] Dr. Katseggelos’s testimony, for its assertion that in 2013, cameras captured images in one aspect ratio and stored or displayed those images in a different aspect ratio.” ID, 35.

A. Ground 1: Fleming Does Not Render Obvious the Challenged Claims

1. Summary of Fleming

102. Fleming is directed to a computer system that adjusts an image’s aspect ratio for an external device. Thus, in Fleming’s computer system, a video signal is received from an external device, such as an “RGB” video connection. The computer system converts the aspect ratio of the image, which is then displayed on an external display. Fleming does not disclose that its computer system contains a camera or other image sensor for capturing images.

2. Fleming Does Not Render Obvious Performing Non-Uniform Shifting on an “Image Capture Apparatus” or “Camera”

103. In my opinion, Petitioner has not shown that Fleming renders obvious the performance of the claimed steps on “a camera” or an “image capture apparatus.”

104. The Challenged Claims require that the transformation be performed by the image capture apparatus itself. For example, claim 1 requires that claimed machine-readable instructions be contained within an “image capture apparatus”

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and that they apply a transformation to the “input image” that is captured by the “image sensor” of the same “image capture apparatus.” Claims 6 and 7 likewise require that the machine readable instructions for applying the transformation be “included within a camera.” For all grounds, including Ground 1, Petitioner focuses on claim 6 first, and then relies on its claim 6 analysis for claim 1’s limitations of “image capture apparatus” and “image sensor.”

105. Petitioner asserts “[i]t would have been obvious for Fleming’s data processing system (including its GPU and CPU) to be included within a camera.” Pet. 28. In particular, Petitioner asserts it would have been obvious to use Fleming’s non-linear distortion in order to convert the aspect ratio of the captured image to the aspect ratio of the image as a stored file or when displayed on an LCD included with the camera. *Id.*

106. But, in my opinion, Petitioner’s analysis is flawed because (1) Petitioner provides no evidence that any camera in 2013 used a different aspect ratio to store images as files or display on an LCD, (2) Petitioner’s “motivation” is conclusory and is not a motivation to apply non-linear distortion in converting the aspect ratio—indeed, it was conventional to reduce as much distortion as possible, and (3) Petitioner does not contend that the combination would have a reasonable expectation of success.

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107. First, Petitioner does not provide any evidence that any cameras in 2013, the earliest effective filing date of the '413 patent, had an “aspect ratio of the captured image [that] was different than the aspect ratio of the stored file or the LCD display included in the camera.” Pet. 28. Without such a difference in aspect ratio, there would not be any reason to use Fleming’s system for converting aspect ratios within a camera. Yet it would be nonsensical to design a camera to capture images in one aspect ratio and store or display them in a different aspect ratio—it would, in fact, be “less burdensome, cheaper, and save[] time” to use the same aspect ratio. *Id.* I further note that Dr. Katsaggelos agreed that conversion of aspect ratio will ***always*** involve some distortion. Ex. 2026, 87:24-88:5.

108. In addition, as I discussed above, non-linear transformations were expensive to design and implement, and required significant processing power to execute. Portable devices and cameras in 2013 had limited processing power and battery life that a POSITA would find undesirably wasted if every photograph had to have its aspect ratio converted due to a mismatch between the image sensor and the display screen. As a result, a POSITA would have found it much more preferable for the camera and display to have the same aspect ratio in order to avoid distortion of the image and the expensive non-linear transformations claimed in the '413 patent.

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109. Moreover, the conventional approach to converting aspect ratio on a portable device was to apply cropping, linear scaling, or padding, which all would have been adequate for the type of preview screens embodied in digital cameras in 2013. This was the approach used by the prior art Nikon D5200 Digital Camera, which I discuss further below in Section VII.F.

110. Second, Petitioner’s “motivation” lacks any substance. Petitioner’s motivation is that “hav[ing] on-camera processing and display capabilities because it would have been less burdensome, cheaper, and saves time.” But this motivation is not tied to the specific teachings of Fleming Petitioner relies on, specifically its use of non-linear distortion to convert aspect ratios from an image on a camera to an external display device such as a television. Petitioner’s generic motivation of “on-camera processing and display capabilities” is something any digital camera in 2013 already had. There is no further motivation to include non-linear distortion for converting aspect ratios on the camera.

111. In my opinion, it would have been “less burdensome, cheaper, and save[more] time” to not perform any aspect ratio conversion, or if performing an aspect ratio conversion, not to perform a non-linear distortion. As I discussed above, POSITA would have understood that the claimed non-linear transformations are generally complex, making them difficult to calculate and

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computationally expensive to implement. Ex. 2026, 40:1-7 (agreeing that linear approximations are used to “avoid the complexities of a non-linear calculation”); 38:23-39:3 (“[I]f it’s an extremely complicated non-linear function, it might take longer to implement.”). This is why prior art like Meulen used piece-wise linear transformations on its portable device that could only at best approximate non-linear transformations, which are “computationally indistinguishable” from linear transformations. Ex. 1007, 40:19-41:8. I agree with Dr. Katsaggelos that the very reason to use piece-wise linear transformations is because they “avoid the complexities of a non-linear calculation”. Ex. 2026, 40:1-7.

112. In fact, in 2013, it was understood that non-linear distortion on an image was undesirable, especially for a still-image camera disclosed in Fleming. This is because non-linear distortion results in distortions that would make the scene look unnatural—especially if there are known objects or persons in the field of view. For example, Exhibit 2003, which is a discussion of the feature that is embodied by the ’413 patent, GoPro SuperView, provides examples of how the distortion from SuperView can look unnatural for still images. For example, the first image below does not use non-linear distortion, whereas the second one does, which has highly visible and jarring distortions.

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113. The article concludes that this functionality is “not especially useful for ... any time that the highly distorted and compressed look is going to appear strange,” such as “standard people shots.” Ex. 2003, 6. Instead, the non-linear

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distortion is more appropriate for “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.” *Id.*

114. In my opinion, a POSITA would by contrast understand that it would be desirable to remove any distortion. For example, many cameras used fish-eye lenses to take wide angle shots, which resulted in distorted images. Numerous prior art references discuss processing such images to remove the distortions. *See, e.g.*, Ex. 2004, Abstract (“A wide angle lens system ***distorts the image*** and conveys it to an image sensor, which converts the image to an electronic signal and conveys it to image processing circuitry. The image processing circuitry ***corrects the distortion*** or transforms it to human recognizable image forms.”); Ex. 2005, Abstract (“A digital photographing apparatus for ***correcting image distortion*** performs an image distortion correcting method.”). Thus, a POSITA would have understood that distortions were undesirable.

115. Thus, not only would the claimed non-linear distortion not be “less burdensome, cheaper, and saves time” as Petitioner asserts, it would instead result in a highly distorted, unnatural look to the still photographs or video of scenery that Fleming contemplates.

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116. Third, Petitioner does not provide any evidence or even assert that the combination would have a reasonable expectation of success. I understand that an obviousness combination must include why a POSITA would have a reasonable expectation of success.

3. *Fleming Does Not Render Obvious “Determine a Portion Within the Input Image”*

117. As I discussed above, the challenged claims each recite a separate step of “determin[ing] a [less-distorted] portion within the input image” **after** obtaining the image and **prior** to the transformation of the image. This limitation was added to the claims to overcome prior art that merely disclosed transformation of an image resulting in a less-distorted portion.

118. Petitioner relies on Fleming’s “graphics processing unit” and “central processing unit” as performing the claimed steps. Pet. 12. Yet for the “determine” step, Petitioner provides **no explanation** as to how the GPU or CPU “determine a portion within the input image” prior to transformation. Pet. 14-15.

119. Below is the entirety of Petitioner’s analysis:

Fleming discloses “maintain[ing] the original aspect ratio in an area of interest (e.g., at the center of the image).” (EX1004, 4:39-40.) In Figure 2 (below), for example, “a square region at the center of image 271 is mapped (or scaled).” (EX1004, 5:1-2, 5:17-66, Figs. 2, 3.) A POSITA would have understood that a region at the center of the image includes a subset of the pixels within the input image. (EX1002, ¶¶59-62.)

Pet. 15.

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120. In my opinion, what’s missing from Petitioner’s analysis is any discussion of how Fleming teaches that the GPU or CPU “determine[s]” the less distorted portion of the image prior to transformation. Although Fleming discloses that an “area of interest” or a “square region at the center” has minimal or no distortion, that simply describes the effect of the transformation. There is no explanation as to how that portion is determined by the CPU or GPU prior to transformation as recited in the claims, a limitation that was specifically added to overcome prior art during prosecution.

121. Instead, a POSITA would understand that Fleming’s “area of interest” is simply programmed as part of the specific implementation of Fleming’s nonlinear scaling without an earlier determination step. This is why Fleming describes the undistorted “area of interest” as part of the process of “scal[ing] nonlinearly” the image. *See, e.g.*, Ex. 1004, 4:49-51 (“In the example of FIG. 2, image 271 is scaled nonlinearly in the horizontal direction”). As I discussed above, Petitioner’s theory is based on a flawed understanding of the patent that does not treat the “determine” step as a separate step and renders it superfluous.

122. This contrasts with the ’413 patent’s specification, where based on numerous factors such as characteristics of the image and desired overall distortion, the system creates a “resolution remapping” where some portions are

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less distorted and other portions are more, and the “remapping” is then applied as a transformation to the image. Ex. 1001, 3:39-45.

123. Thus, in my opinion, Petitioner does not show that Fleming discloses or renders obvious the “determine” step.

B. Ground 3: Obara Does Not Render Obvious the Challenged Claims

1. Summary of Obara

124. Obara is also directed to a “personal computer” that performs AV processing similar to “audio/video (AV) apparatuses such as DVD (Digital Versatile Disc) players and TV apparatuses.” Ex. 1006, ¶9. Thus, in Obara, the image that is processed is “received by the TV tuner.” *Id.*, ¶34.

2. Obara Does Not Render Obvious Performing Non-Uniform Shifting on an “Image Capture Apparatus” or “Camera”

125. Petitioner’s assertions for Obara are similar to its assertions for Fleming. Petitioner does not contend Obara discloses a “camera” or an “image capture apparatus.” Pet. 71-72 (analyzing claim 6), 78-79 (relying on claim 6 analysis). Petitioner argues it would have been obvious “for Obara’s image processing unit and CPU 111 to be included within a camera” for the same reasons as given for Fleming. Pet. 71-72.

126. In my opinion, these arguments fail for the same reasons I discussed for Ground 1—namely, that Petitioner does not provide any evidence of cameras

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that performed aspect ratio conversion on-camera, and that a POSITA would not find it desirable to perform non-linear distortion on the still images captured by Obara's device. Moreover, Petitioner fails to assert that the combination would have a reasonable expectation of success.

3. *Obara Does Not Render Obvious "Determine a Portion Within the Input Image"*

127. For Ground 3, in my opinion, Petitioner has not shown how Obara discloses or renders obvious the "determine" step.

128. Petitioner relies on Obara's "CPU" as performing the claimed steps. Pet. 51. Yet as with Ground 1, Petitioner does not provide any explanation as to how the CPU "determine[s] a portion within the input image." Pet. 55-58. Instead, Petitioner only quotes Obara's disclosure that the "non-linear scaling module 215 vertically divides the original image data (A) into, for example, eight image blocks" where "blocks 3, 4, 5 and 6 which belong to the central area." Pet. 56. Petitioner then asserts that "blocks 3-6 at the central area" is the claimed portion. Pet. 56. No discussion is given as to how Obara's CPU determines that those blocks are the claimed portion, or how it is a separate step performed after receiving the image and before the transformation. I again note this is in contrast to the disclosures of the '413 patent wherein, based on a number of factors from the obtained image (e.g. location of an object within the input image, size of an

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object in the input image, or the motion of an object in video frames), the less distorted portion and the more distorted portion are determined as a “resolution remapping,” which is performed by applying a transformation to the image. Ex. 1001, 3:39-45, 4:32-36, 4:37-46. The less distorted portion and the more distorted portion, and therefore the resolution remapping can change depending on said factors. *Id.*

VII. SECONDARY CONSIDERATION OF NON-OBVIOUSNESS

129. In my opinion, there is strong, objective evidence that the ’413 patent is not obvious. Patent Owner GoPro, Inc. (“GoPro”) successfully manufactured and sold action cameras that include the SuperView functionality, which embodies the ’413 patent.

A. SuperView Practices the ’413 Patent

130. In my opinion, GoPro action cameras with SuperView practice at least claim 1 of the ’413 patent. My analysis below focuses on the GoPro HERO7,

[REDACTED]

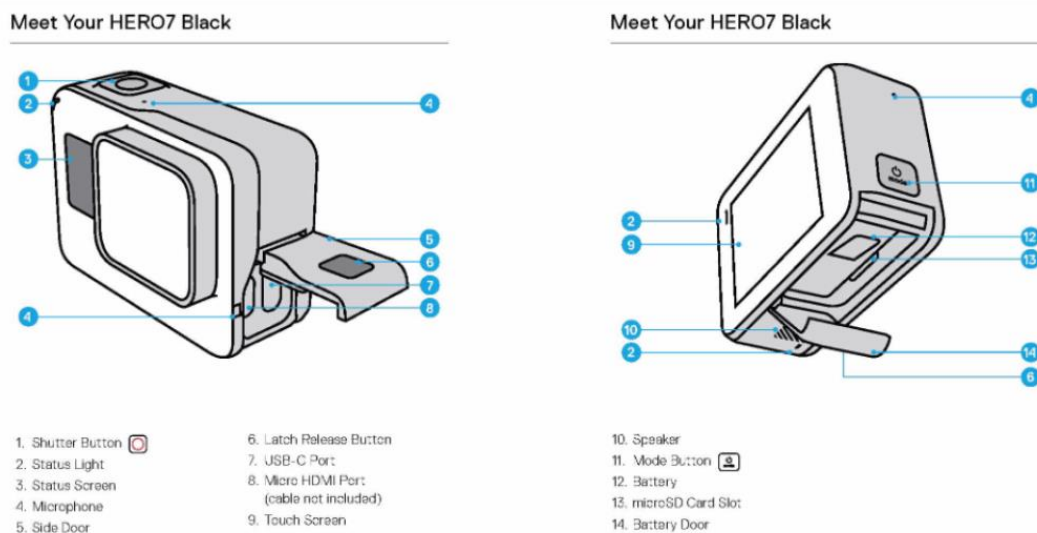
[REDACTED] In addition, I understand that in the ITC litigation, Petitioner did not dispute that the HERO7 practices claim 1.

1. 1[pre]: An image capture apparatus, comprising:

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131. In my opinion, the HERO7 practices this limitation. The HERO 7 and other GoPro action cameras are image capture apparatuses.

132. For example, the GoPro HERO7 has a video camera, and SuperView converts the aspect ratio of the captured video. Ex. 2028, 4, 47 (“SuperView stretches 4:3 content to fit a 16:9 screen.”); Ex. 2010, 1 (“Superview allows you to capture an immersive, wide-angle perspective. This mode takes a 4:3 aspect ratio video and dynamically stretches it to a 16:9 aspect ratio video.”).



2. 1[a]: an image sensor configured to capture an input image having a source aspect ratio, the input image including pixels located at input positions defined along a first axis and a second axis, the first axis perpendicular to the second axis;

133. In my opinion, the GoPro action cameras practice this limitation.

134. GoPro action cameras with SuperView have an image sensor which captures an input image with a source aspect ratio of 4:3. Ex. 2010, 1. For

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example, the HERO7 “has a 12MP sensor that produces images in a 4:3 aspect ratio.” Ex. 2029, 3.

3. 1[b]: a display coupled to one or more physical processors; and

135. In my opinion, the GoPro action cameras practice this limitation.

136. GoPro action cameras with SuperView have a display coupled to a physical processor. For example, the HERO7 has a [REDACTED]

[REDACTED]

4. 1[c]: the one or more physical processors configured by machine-readable instructions to:

137. In my opinion, GoPro action cameras practice this limitation.

138. The HERO7 has a [REDACTED] that stores code that runs on the processor. Ex. 2030, 1.

5. 1[d]: obtain the input image;

139. In my opinion, GoPro action cameras practice this limitation for the same reasons I discussed for limitation 1[a], since the image sensor captures an image and provides it to the processor for processing.

6. 1[e]: determine a portion within the input image, the portion including a subset of the pixels; and

140. In my opinion, GoPro action cameras practice this limitation.

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141. GoPro action cameras use a warping grid that determines a portion within each frame of a captured video, *i.e.* the input image. Different video settings are selectable (SuperView, Wide or Linear), which affects which code is used to compute the warping grid. Ex. 2028, 16.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

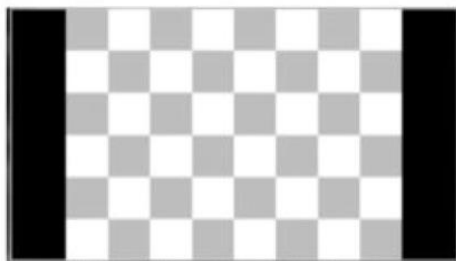
[REDACTED]

7. 1[f]: apply a transformation to the input image to generate an output image, the output image having a target aspect ratio different than the source aspect ratio, the output image including the pixels located at output positions defined along the first axis and the second axis, wherein:

146. In my opinion, GoPro action cameras practice this limitation.

147. SuperView converts an 4:3 input image to a 16:9 output image by

[REDACTED]. Ex. 2010, 1 (“This mode takes a 4:3 aspect ratio video and dynamically stretches it to a 16:9 aspect ratio video.”); Ex. 2028, 47.



Standard 4:3 Aspect Ratio image

- Footage is captured in a tall 4:3 aspect ratio to frame all the action but does not fill the screen when played back



SuperView

- The camera dynamically stretches the footage to a wide 16:9 aspect ratio for full screen playback.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

[REDACTED]

8. 1[g]: 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; and

149. In my opinion, GoPro action cameras practice this limitation.

[REDACTED]

[REDACTED]

[REDACTED]

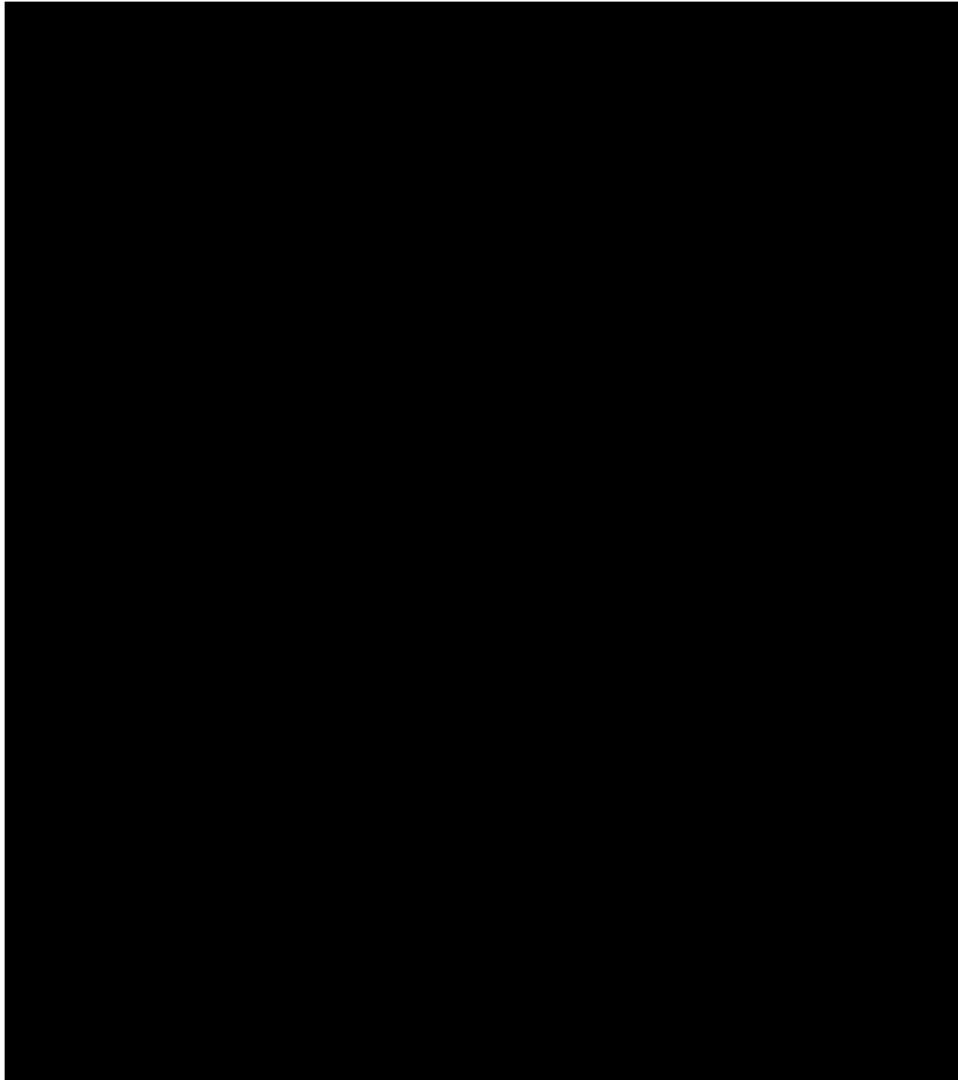
9. 1[h]: the transformation non-uniformly shifts the pixels such that differences between the input positions and the output positions of the subset of the pixels within the portion are less than differences between the input positions and the output positions of others of the pixels; and

151. In my opinion, GoPro action cameras perform this limitation.

[REDACTED]

[REDACTED]

[REDACTED]

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10. *1[i]: present the output image on the display.*

153. In my opinion, GoPro action cameras practice this limitation.

154. The SuperView-enhanced image is presented on the display of the action camera. Ex. 2028, 47 (“SuperView stretches 4:3 content to fit a 16:9 screen.”); Ex. 2010, 1 (“Superview allows you to capture an immersive, wide-angle perspective. This mode takes a 4:3 aspect ratio video and dynamically stretches it to a 16:9 aspect ratio video.”).

PUBLIC VERSION**B. Nexus**

155. I have reviewed the declaration of Mr. Pablo Nema, who explains how there is a nexus from SuperView to the objective evidence I describe below. Ex. 2024.

C. Copying

156. I have seen evidence of copying, including by Petitioner. Petitioner's products use a feature called ActionView, whose description and name is quite similar to SuperView. Ex. 2009. Petitioner describes ActionView as "optimized specifically for action PoV shots, with a taller height" and that it should be used for shots that have an "immersive first-person view, ideal for skiing, cycling and more." *Id.* This description is quite similar to how GoPro describes the SuperView functionality, such advertising that it is optimized for immersive first-person views, such as for skiing and biking: "When to use Superview... Activities with the camera mounted on your head or chest, such as biking, skiing, motocross, etc., all work great—anything without a lot of important focal items around the edges of the frame." Ex. 2010, 1.

157. I understand that SuperView functionality has been in GoPro cameras since at least 2014 if not earlier. By contrast, I also understand that Patent Owner was not founded until 2015, and that ActionView does not appear to have been released until after 2020.

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[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

159. I have also seen evidence of others who have copied SuperView. For example, a “superview” project is described as “[a] small program that takes a 4:3 aspect ratio video file, and transforms it to a 16:9 video using the GoPro SuperView method.” Ex. 2011. Another called “SuperViou” is similarly described. Ex. 2012.

D. Industry Praise

160. I have seen evidence of industry praise for SuperView. In a review by New Atlas on October 5, 2014, it characterizes SuperView as a “clever” feature that “is designed to capture a more immersive wide angle perspective.” Ex. 2013.

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I understand that New Atlas has a significant presence in the industry, having a readership of “approximately four million unique visitors a month” and covers “advances in technology, science, transportation, architecture, design, and many other disciplines.” Ex. 2014.

161. Others have also praised SuperView. One reviewer described “GoPro’s unique Superview lens” which provides “a ridiculously wide angle which allowed even a selfie taken from just arms reach to capture all six of our family!” Ex. 2015.

162. User posts from the forum of a competitor called DJI have also praised SuperView and expressed a desire for DJI’s products to have a similar feature. Below are a few examples of such praise. Ex. 2016.

- “Hello, is there **any chance on getting a Superview-like mode** like the one in the Hero 7? Asking this because i bought the Osmo Action but since i'm a biker i think **it's a very important feature** and now i feel like i want to send the osmo back and buy a Hero 7.” (Post #1)
- “Hi, thank you for bringing this query for us. **As of the moment. we don't have this feature for the DJI Osmo Action.**” (Post #2)
- “Can you explain what ‘superview mode’ is?” (Post #4)
- “**It's the famous GoPro mode** that enable the camera to record video in 4:3 to gain FOV and then stretch the image to reach the 16:9 ratio.” (Post #5)

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- “Thanks very much for the info and links. **Technology is amazing** - they stretch out the sides or edges to fill the frame - **neat trick.**” (Post #7)
- “**2020 already, please for Superview Mode**” (Post #19)
- “**Any updates of when the superview like feature for Osmo action might land?** That would be a **game changer** and many of **my friends want to buy Osmo action but are retreating** because of this missing feature” (Post #21)
- “Hi, **wondering if this was ever considered?** I ended up buying a few of the original Osmo Action cameras and **this would be an awesome feature.** Converting in post is just torture. **A superview for motovlogging is a must.**” (Post #26)

163. Another post from the same forum describes SuperView as “essential” for DJI to add to the next firmware for their products. Ex. 2017 (post #28 and 30).

164. The HERO7 Black has also received industry praise, and as I discussed above, Mr. Lema explains how such praise is tied to the SuperView feature. Ex. 2023. For example, because of the HERO7 Black, GoPro won the 2019 Consumer Electronics Show (“CES”) award, as well as the prestigious “Lucie” award, recognizing significant achievement in the photographic industry. Ex. 2036; Ex. 2037; Ex. 2038. GoPro also won the 73rd Technology and Engineering Emmy award. Ex. 2039; Ex. 2041.

PUBLIC VERSION**E. Commercial Success**

165. Mr. Lema explains how GoPro saw significant success with the HERO7 Black, which SuperView contributed to. Ex. 2023, ¶¶5-13; Ex. 2040, 10-14; 2019, 14.

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

[REDACTED]

F. Long-Felt Need and Unexpected Results

168. I have also seen evidence of a long-felt need and unexpected results with respect to SuperView. The '413 patent states that prior to its invention “[c]onverting between aspect ratios [was] a common problem in the field of image and video processing.” Ex. 1001 at 1:6-7. “Conventional conversion techniques such as cropping, linearly scaling, and padding each result[ed] in a perceivable reduction in the quality of an image or video.” *Id.* at 1:11-13. For example, cropping would “remove[] content from the image and reduce[] the field of view of

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the image.” *Id.* at 1:14-15. “Linear scaling,” on the other hand could “maintain[] the full field of view” but would “introduce[] perceivable distortion into the image.” *Id.* at 1:16-18.

169. At the time of the ’413 patent, conventional wisdom was that introducing distortion into images was undesirable. For instance, distortion, particularly geometric distortion, can stretch or compress parts of the image in an uneven way, making faces or bodies look elongated, squished, or warped. This effect is especially undesirable in personal or group photos, where people expect to see a realistic representation of themselves. Because of these reasons, photographers and camera designers traditionally seek to avoid or minimize distortion to maintain the integrity, realism, and appeal of their photos. Indeed, GoPro explains on its website that Superview should not be used in conventional camera settings: “Avoid using SuperView when people are on the edges of the frame since they will be stretched a bit.” Ex. 2010, 1.

170. Given these challenges, a user of a camera was generally limited to capturing images with an output field of view having the same aspect ratio of the intended display or if aspect ratio conversion was performed it was done so as to avoid distortion. For instance, in the ITC litigation, Petitioner relies on the Nikon D5200 Digital Camera as prior art. The D5200 manual is consistent with the ’413

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patent's description of the art. It applies conventional cropping based on user selection to create an associated image for a preview function (for video files), or a rote aspect ratio change (for image file). Ex. 2020, 120-21 ("Rotate the command dial to switch between aspect ratios of ratio 3:2, 4:3, 5:4, 1:1, and 16:9."; "Use multi selector to position the crop."). In other words, the D5200 reflects the conventional understanding of how cameras should perform aspect ratio conversion when displaying images on the camera by teaching the type of conventional cropping that the specification of the '413 patent improves upon. Ex. 1001 at Abstract, 1:7-25, 5:9-13.

171. While conventional cameras seeks to eliminate distortion when displaying on the preview screen, GoPro took a 180-degree approach: introducing distortion when displaying on the screen. In particular, GoPro's SuperView invention utilizes a sensor that captured an image in one aspect ratio (4:3) so that the image can be "taller," and then allowed it to be displayed and previewed on the screen in aspect ratios that are more commonly used in video settings (*e.g.*, 16:9). To do this, however, GoPro had to intentionally introduce distortion into the image. SuperView thus applies a warping function that distorts the edges while eliminating distortion in the center. GoPro's unconventional approach arises from the fact that GoPro's cameras are directed at action sports, not conventional

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photography. GoPro recognized that video for certain action sport scenes, like skiing, surfing and bicycling, result in persons being centered in the middle of the shot, with no persons on the edges. This means that the periphery can be distorted in an acceptable manner.

172. Consider surfing as one example. A surfer capturing himself in a “barrel” benefits from a taller image because he or she can see more of the wave, and the distortion at the periphery is acceptable because the focus of the capture is in the middle where the action takes place, instead of the periphery, as can be seen in the image below taken with SuperView:



Ex. 2021.

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173. Thus, in my opinion, the SuperView functionality met the long-felt need of producing high-quality, wide-angle video for action cameras through the use of non-linear distortion, which was an unexpected result.

VIII. CONCLUSION

174. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

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

Executed: April 18, 2025

/s/ Hassan Foroosh
Hassan Foroosh, Ph.D.