UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner

v.

COREPHOTONICS, LTD.,
Patent Owner

Case IPR2018-01133
Patent No. 9,538,152

PETITIONER APPLE INC.'S ORAL HEARING DEMONSTRATIVE EXHIBITS

In accordance with the Order – Oral Hearing (Paper 29), Petitioner Apple Inc. hereby files its oral hearing demonstrative exhibits.

Respectfully submitted,

October 3, 2019

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Registration No. 40,107

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Apple Inc.	§	Petition for *Inter Partes* Review
Petitioner	§	
	§	IPR2018-01133
	§	U.S. Patent No. 9,538,152
	§	

CERTIFICATE OF SERVICE

The undersigned certifies, in accordance with 37 C.F.R. § 42.6, that service was made on Patent Owner as detailed below.

Date of service	October 3, 2019
Manner of service	Electronic Service by E-Mail
Documents served	Petitioner's Oral Hearing Demonstrative Exhibits
Persons served	Neil A. Rubin (nrubin@raklaw.com) C. Jay Chung (jchung@raklaw.com) Reza Mirzaie (rmirzaie@raklaw.com) Marc A. Fenster (mfenster@raklaw.com)

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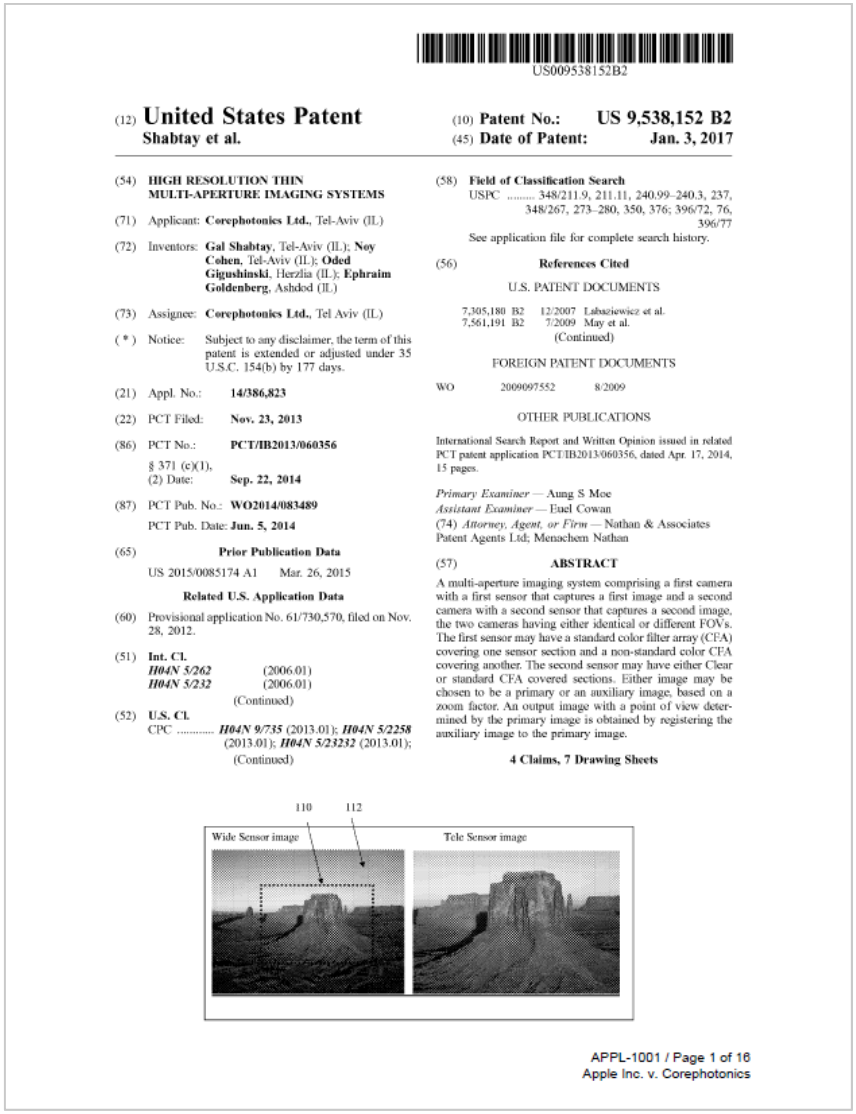
Inter Partes Review
U.S. Patent No. 9,538,152

Apple Inc. v. CorePhotonics, Ltd., Case IPR2018-01133

David O'Brien, Haynes and Boone, LLP

Claims 1-4 Obvious over Border in view of Parulski



US009538152B2

(12) **United States Patent**
Shabtay et al.

(10) **Patent No.: US 9,538,152 B2**
(45) **Date of Patent: Jan. 3, 2017**

(54) **HIGH RESOLUTION THIN MULTI-APERTURE IMAGING SYSTEMS**

(71) Applicant: **Corephotonics Ltd.**, Tel-Aviv (IL)

(72) Inventors: **Gal Shabtay**, Tel-Aviv (IL); **Noy Cohen**, Tel-Aviv (IL); **Oded Gigushinski**, Herzlia (IL); **Ephraim Goldenberg**, Ashdod (IL)

(73) Assignee: **Corephotonics Ltd.**, Tel Aviv (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 177 days.

(21) Appl. No.: **14/386,823**

(22) PCT Filed: **Nov. 23, 2013**

(86) PCT No.: **PCT/IB2013/060356**
§ 371 (c)(1),
(2) Date: **Sep. 22, 2014**

(87) PCT Pub. No.: **WO2014/083489**
PCT Pub. Date: **Jun. 5, 2014**

(65) **Prior Publication Data**
US 2015/0085174 A1 Mar. 26, 2015

Related U.S. Application Data
(60) Provisional application No. 61/730,570, filed on Nov. 28, 2012.

(51) **Int. Cl.**
H04N 5/262 (2006.01)
H04N 5/232 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04N 9/735*** (2013.01); ***H04N 5/2258*** (2013.01); ***H04N 5/23232*** (2013.01);
(Continued)

(58) **Field of Classification Search**
USPC 348/211.9, 211.11, 240.99–240.3, 237, 348/267, 273–280, 350, 376; 396/72, 76, 396/77
See application file for complete search history.

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Primary Examiner — Aung S Moe
Assistant Examiner — Euel Cowan
(74) *Attorney, Agent, or Firm* — Nathan & Associates Patent Agents Ltd; Menachem Nathan

(57) **ABSTRACT**

A multi-aperture imaging system comprising a first camera with a first sensor that captures a first image and a second camera with a second sensor that captures a second image, the two cameras having either identical or different FOVs. The first sensor may have a standard color filter array (CFA) covering one sensor section and a non-standard color CFA covering another. The second sensor may have either Clear or standard CFA covered sections. Either image may be chosen to be a primary or an auxiliary image, based on a zoom factor. An output image with a point of view determined by the primary image is obtained by registering the auxiliary image to the primary image.

4 Claims, 7 Drawing Sheets

APPL-1001 / Page 1 of 16
Apple Inc. v. Corephotonics

1. A multi-aperture imaging system comprising:

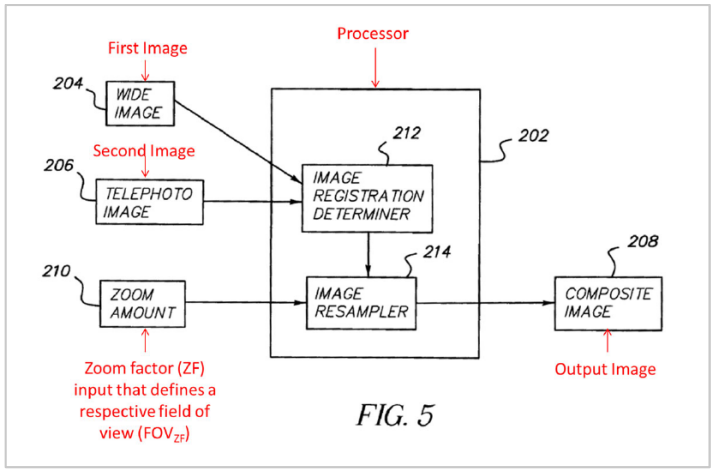
a) a first camera that provides a first image, the first camera having a first field of view (FOV_1) and a first sensor with a first plurality of sensor pixels covered at least in part with a standard color filter array (CFA);

b) a second camera that provides a second image, the second camera having a second field of view (FOV_2) such that $FOV_2 < FOV_1$ and a second sensor with a second plurality of sensor pixels, the second plurality of sensor pixels being either Clear or covered with a standard CFA, the second image having an overlap area with the first image; and

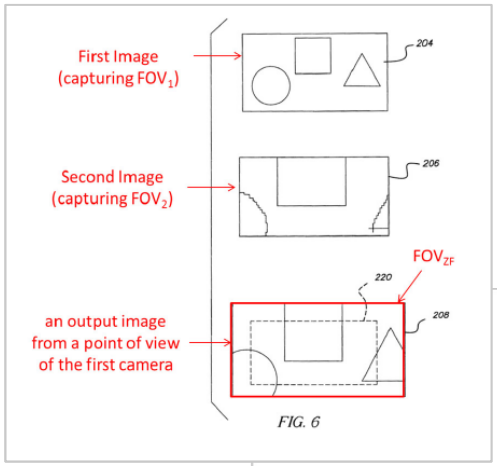
c) a processor configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}), the first image being a primary image and the second image being a non-primary image, wherein if $FOV_2 < FOV_{ZF} < FOV_1$ then the point of view of the output image is that of the first camera, the processor further configured to register the overlap area of the second image as non-primary image to the first image as primary image to obtain the output image.

('152 Patent, claim 1) Ex. 1001, 12:60-13:13.

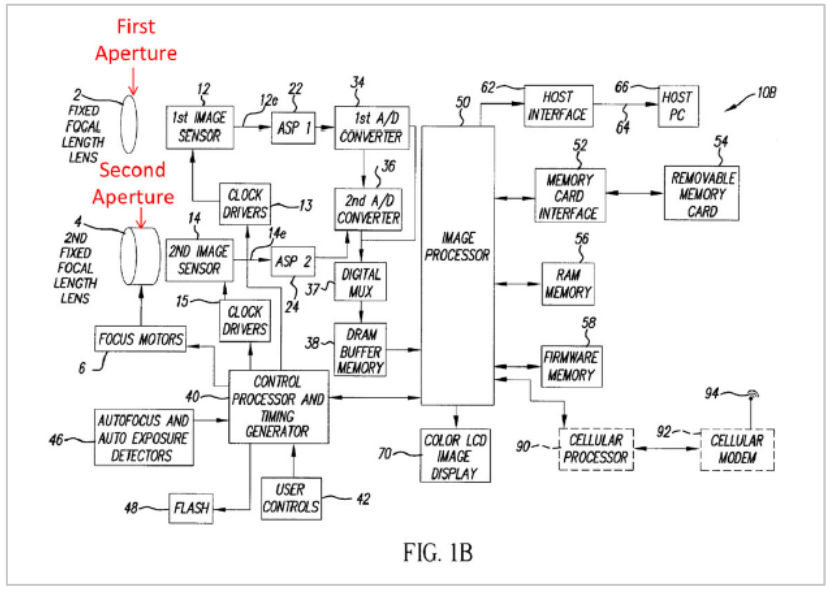
Claims 1-4 Obvious over Border in view of Parulski



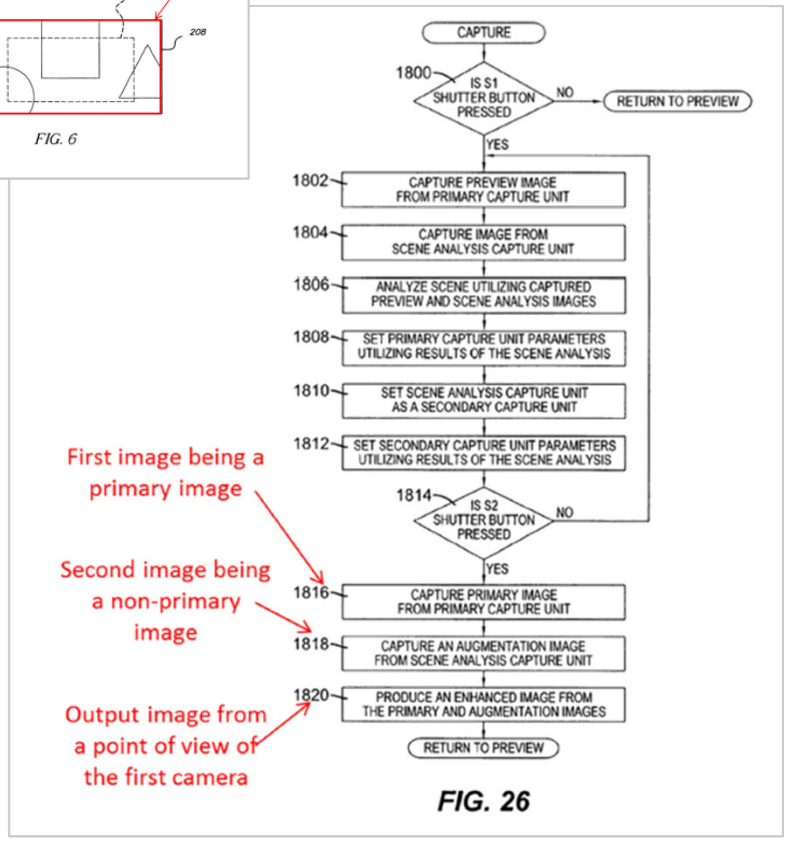
(Border) Ex. 1006, Fig. 5, annotated; Petition at 41.



(Border) Ex. 1006, Fig. 6, annotated; Petition at 45.



(Border) Ex.1006, Fig. 1B, annotated; Petition at 22



(Parulski) Ex. 1007, Fig. 26 (annotated); Petition at 51; *see also* Reply at 10; (Cossairt) Ex. 1004 at 55.

Discussion Summary

- Claim Construction
- Border and Parulski would have been combined
- Border and Parulski teach point of view limitations
- Border and Parulski teach primary/non-primary images limitations
- Border and Parulski teach an output image from a point of view of the second camera if $FOV_2 \geq FOV_{ZF}$

Discussion Summary

- Claim Construction

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Claim construction – “standard color filter array (CFA)”

No need to construe: undisputed that Border teaches claim 1 elements (a) and (b)

1. A multi-aperture imaging system comprising:
a) a first camera that provides a first image, the first camera having a first field of view (FOV_1) and a first sensor with a first plurality of sensor pixels covered at least in part with a standard color filter array (CFA);
b) a second camera that provides a second image, the second camera having a second field of view (FOV_2) such that $FOV_2<FOV_1$ and a second sensor with a second plurality of sensor pixels, the second plurality of sensor pixels being either Clear or covered with a standard CFA, the second image having an overlap area with the first image; and
c) a processor configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}), the first image being a primary image and the second image being a non-primary image, wherein if $FOV_2<FOV_{ZF}<FOV_1$ then the point of view of the output image is that of the first camera, the processor further configured to register the overlap area of the second image as non-primary image to the first image as primary image to obtain the output image.

(‘152 Patent, claim 1) Ex. 1001, 12:60-13:13.

Claim construction – “point of view”

Petitioner
no construction/“viewpoint”

58; (APPL-1004), Cossairt, ¶122. A POSITA would have understood that such an enhanced primary image is from a point of view of the primary image, wide image 204 (the first image). (APPL-1004), Cossairt, ¶122; *see also* (APPL-1008), Jacobson, 5, 57-58 (explaining that “viewpoint is the centre of the pupil of the eye of the observer,” and when a scene is captured by an imaging system, “the camera lens takes the place of the eye”); (APPL-1010), Szeliski, Fig. 2.12, 50-51.

Petition at 54; *see also* (Cossairt) Ex. 1004, ¶114.

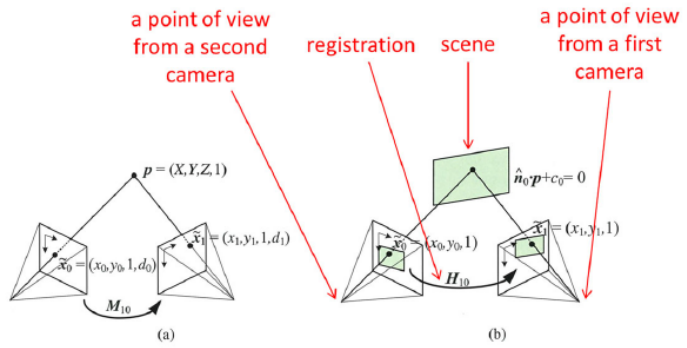

Figure 2.12 A point is projected into two images: (a) relationship between the 3D point coordinate $(X, Y, Z, 1)$ and the 2D projected point $(x, y, 1, d)$; (b) planar homography induced by points all lying on a common plane $\hat{n}_0 \cdot p + c_0 = 0$.

Patent Owner
No construction/”camera angle”

The Petition did not identify the term “point of view” as a term for construction. Corephotonics believes that the term “point of view” requires no construction. Nonetheless, as explained below, Apple’s arguments appear to be

...

Should the Board conclude that it is necessary to construe “point of view,” that term should be construed as “camera angle.” Ex. 1001, at 9:26-28; Kosmach Decl., ¶¶ 25-29. The “point of view” of a given image is the visual perspective provided by the “camera angle” of the image. *Id.* Because each camera in a MAI

Response at 13.

Ex. 1010, Fig. 2.12 (annotated);
Petition at 47; (Cossairt) Ex. 1004, ¶114.

No construction ("viewpoint" or "camera angle") requires absence of occlusions

PO's importation of "occlusion" contradicts its own expert's testimony.

The presence of occlusions (or "discontinuities") in a composite image is a function of the different **camera angles** of the input cameras. In other words, the presence of an occlusion means necessarily that the composite image includes image data from at least two different camera angles or points of view.

Sur-Reply at 6.

contradict

Q. -- in a dual-aperture camera system, okay, and the registration process cannot resolve the occlusion issues between the two images, does that still fall within the scope of Claim 1?

A. Yes.

(Kosmach Depo) Ex. 1011 at 147

The '152 Patent does not mention occlusion.

from this actual requirement, Patent Owner seeks to import an extraneous requirement that the output image is without occlusion or parallax artifacts. *See* Response, 22-26. The maneuver seeks to avoid express claim construction.

However, such extraneous requirements are not supported by the '152 Patent. The '152 Patent does not mention occlusion or parallax, much less any solution to such "requirements" that Patent Owner now formulates years after patent grant. APPL-1013, ¶29. The Response and Dr. Kosmach's declaration do not provide any credible basis for a stealth construction of any term to require an output image free of any occlusion or parallax artifact. In fact, Dr. Kosmach admitted that a dual-aperture camera system that cannot resolve occlusion issues still falls within the scope of claim 1. APPL-1011, 147.

Reply at 16.

No need to construe "point of view"

PO believes that the term requires no construction.

> The Petition did not identify the term "point of view" as a term for construction. Corephotonics believes that the term "point of view" requires no construction. Nonetheless, as explained below, Apple's arguments appear to be

Response at 13.

PO's proposed construction "camera angle" does not materially change Petitioner's analysis.

> To the extent the Board adopts Patent Owner's proposed construction of "*point of view*" as "camera angle," such a construction does not materially change Petitioner's analysis. APPL-1013, ¶3; *see also* APPL-1011, 40-41 (Patent Owner's expert defining point of view as a "viewpoint," the construction used by Petitioner).

Reply at 2.

PO and its expert use “point of view” and “viewpoint” interchangeably

Cossairt. Ex. 1008, at 59; *see* Kosmach Decl., ¶36. In the bottom image, taken from one point of view, the left side wall of the building is visible. In the top image, taken from another point of view, that left side wall is not visible, as it is behind the front wall of the building. Ex. 2004, at 51:1-13, 52:9-20.

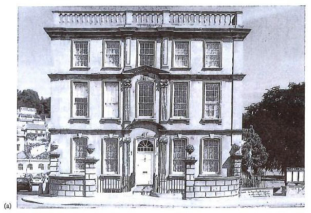

Figure 4.24 Perspective and viewpoint. (a) Distant central viewpoint. (b) Closer oblique viewpoint

Response at 22-24.

Figure 4.24 Perspective and viewpoint. (a) Distant central viewpoint. (b) Closer oblique viewpoint

Does the '152 patent provide a special meaning to "point of view" that would differ from the understanding of a person of ordinary skill in the art at the time of the invention?

A. I think it clarifies their position on what viewpoint is, sure.

(Kosmach Depo) Ex. 1011 at 40-41; Reply at 2.

PO's shifted construction on "point of view" in sur-reply should not be considered

The Petition did not identify the term "point of view" as a term for construction. Corephotonics believes that the term "point of view" requires no construction. Nonetheless, as explained below, Apple's arguments appear to be based on a misunderstanding of the term "point of view" which is inconsistent with its plain and ordinary meaning and as how it is used in the '152 Patent.

Response at 13.

A. The PTAB Should Construe "Point of View" as "Camera Angle"

The Reply makes clear that the claim term "point of view" requires construction. Though neither party initially proposed that "point of view" be construed, the Petition appeared to apply an understanding of that term inconsistent with its plain meaning. *See* Patent Owner Response (Paper 15, "POR"), at 15-16. Accordingly, Corephotonics stated that a POSITA would have understood "point of view" to mean "camera angle." *Id.* On Reply, Apple asserts that construing "point

Sur-reply at 2.

Discussion Summary

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- Border and Parulski teach primary/non-primary images limitations
- Border and Parulski teach an output image from a point of view of the second camera if $FOV_2 \geq FOV_{ZF}$

Parulski explains why and how to combine Border and Parulski

The augmentation process can also be applied in connection with image pairs having different resolutions. For instance, in commonly-assigned, copending U.S. patent application Ser. No. 11/461,574 (which was filed Aug. 1, 2006 in the names of John Border, Scott Cahall and John Griffith, and entitled "Producing Digital Image with Different Resolution Portions"), which is incorporated herein by reference, a first wide angle digital image of a scene and a second telephoto digital image of a portion of substantially the same scene are captured by two capture stages. A composite image is then formed by combining a portion of the first wide angle digital image and a portion of the telephoto digital image, to produce a digital image with improved resolution during digital zooming. More specifically, digital zooming of the composite image produces a zoomed image with high resolution throughout the zoom range with improved image quality.

How

Why

(Parulski) Ex. 1007, 29:51-67, cited in Petition at 20.

Petitioner explains why and how to apply Parulski's image augmentation in Border

A POSITA would have been motivated to apply Parulski's teachings for modifying a primary image using a secondary image to generate an enhanced primary image, where the primary image is determined based on a relationship between a zoom position input and the zoom ranges of the capture units in Border's multi-lens digital camera because the combination would provide the benefits of enhanced image quality (e.g., a broadened dynamic range or a broadened depth of field) in such a digital camera. (APPL-1004), Cossairt, ¶122.

See also Ground 1: Reasons to Combine Border and Parulski.

How

Why

Petition at 53-54; *see also* Reply at 11-14.

Petitioner explains why and how to apply Parulski's image augmentation in Border

It would have been obvious to a POSITA that in the combination, when the zoom amount 210 Z is between 1 and M, the wide image 204 (first image) is primary image as Z is within the zoom range (e.g., from 1 to M) of the wide camera, and the telephoto image 206 (second image) is non-primary image, and the telephoto image 206 is used to modify the wide image 204 to generate a composite image 208 that is an enhanced primary image. (APPL-1006), Border, [0037], [0044], [0058]; (APPL-1007), Parulski, Figs. 15A, 15B, 16A, 16B, 23:28-40, 23:53-58; (APPL-1004), Cossairt, ¶122. A POSITA would have understood that such an enhanced primary image is from a point of view of the primary image, wide image 204 (the first image). (APPL-1004), Cossairt, ¶122; *see also* (APPL-1008), Jacobson, 5, 57-58 (explaining that "viewpoint is the centre of the pupil of the eye of the observer," and when a scene is captured by an imaging system, "the camera lens takes the place of the eye"); (APPL-1010), Szeliski, Fig. 2.12, 50-51.

Petition at 54; *see also* Reply at 9-10 .

PO's no-combination argument mischaracterizes Border's image stitching as *quilt-block style*

Pet., at 48 (emphasis in Petition). As discussed above, however, the simple homography registration technique at the heart of Border's image stitching system has no use for the Parulski's teaching of "determining the primary image and secondary image from two capture units" (Pet., at 17). In other words, Border's

Response at 32.

overlap region. *Id.* But because the simple homography of Border does not account or correct for all differences that occur between images with different points of view, the use case of Border's simple homography is limited to the image stitching technique which produce composite images with multiple points of view (and, therefore, parallax artifacts relating to objects in the scene). *Id.*

Response at 30; *see also* Response, 2, 9, 20-22, 29-30.

PO fails to rebut Reply:

stitching context. The mischaracterization is inconsistent with Border's teachings, contrary to a POSITA's understanding of image stitching technology (APPL-1013, ¶¶6-8), and supported only by the declaration of Dr. Kosmach, who admitted in deposition his lack of knowledge and expertise in image stitching (APPL-1011, 164:9-13).

Reply at 3; *see also* (Cossairt Reply Depo) Ex. 2010 at 15-16.

Q. Okay. So as you sit here today, you don't know what image stitching includes and does not include because you're not an expert in that area, correct?

A. That -- that's fair to say, yes.

(Kosmach) Ex. 1011, 164:9-13, cited in Reply at 3, 5.

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- Border and Parulski teach an output image from a point of view of the second camera if $FOV_2 \geq FOV_{ZF}$

Claim 1 - point of view limitations [1.8] and [1.10]

1. A multi-aperture imaging system comprising:

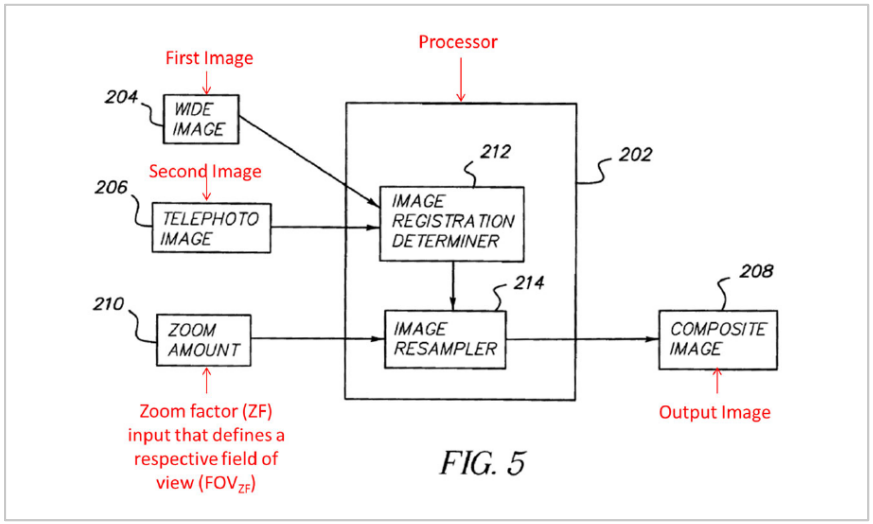
a) a first camera that provides a first image, the first camera having a first field of view (FOV_1) and a first sensor with a first plurality of sensor pixels covered at least in part with a standard color filter array (CFA);

b) a second camera that provides a second image, the second camera having a second field of view (FOV_2) such that $FOV_2<FOV_1$ and a second sensor with a second plurality of sensor pixels, the second plurality of sensor pixels being either Clear or covered with a standard CFA, the second image having an overlap area with the first image; and

c) a processor configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}), the first image being a primary image and the second image being a non-primary image, wherein if $FOV_2<FOV_{ZF}<FOV_1$ then the point of view of the output image is that of the first camera, the processor further configured to register the overlap area of the second image as non-primary image to the first image as primary image to obtain the output image.

('152 Patent, claim 1) Ex. 1001, 12:60-13:13.

Border teaches point of view limitations [1.8] and [1.10]



(Border) Ex. 1006, Fig. 5, annotated; Petition at 41.

A POSITA would have understood that the composite image 208 that is generated by modifying the wide image 204 using the telephoto image 208 with registration information (e.g., represented by homography H_{TW}) that "transforms the coordinates of the telephoto image 206 **to** the wide image 204" has the same point of view as the wide image 204. (APPL-1006), Border, [0038]-[0040], [0042], [0048]; (APPL-1010), Szeliski, Fig. 2.12, 50-51; (APPL-1008), Jacobson, 5, 57-58; (APPL-1004), Cossairt, ¶114. Specifically, Dr. Cossairt confirms that it was well

Petition at 46; *see also* Reply at 17.

Border teaches using registration (e.g., in the form of homography) to transform the telephoto image to the point of view of the wide image

(APPL-1004), Cossairt, ¶114. Specifically, Dr. Cossairt confirms that it was well known in the art to use registration (e.g., in the form of homography) to map an image having a point of view from one camera to another image having a point of view from another camera, which is "commonly used in image-stitching applications." (APPL-1010), Szeliski, Fig. 2.12, 50-51; (APPL-1004), Cossairt, ¶114. For example, as illustrated in Figure 2.12 of Szeliski below, based on a registration in the form of homography $\mathbf{H}_{10}$, pixels $\tilde{\mathbf{x}}_0$ in a second image of a scene with a point of view from a second camera are mapped to pixels $\tilde{\mathbf{x}}_1$ in a first image of that same scene with a point of view from a first camera. (APPL-1010), Szeliski, Fig. 2.12, 50-51; (APPL-1004), Cossairt, ¶114.

Petition at 46-47; *see also* Reply at 3-4, 17.

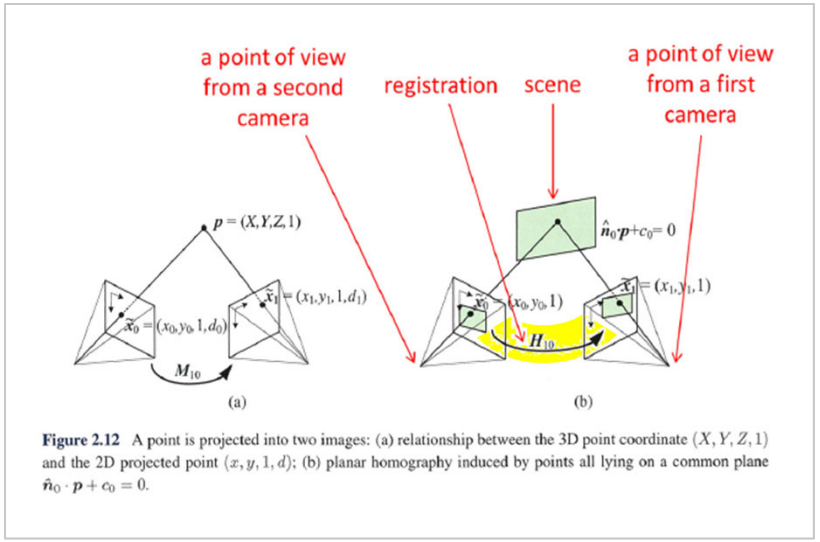


Figure 2.12 A point is projected into two images: (a) relationship between the 3D point coordinate $(X, Y, Z, 1)$ and the 2D projected point $(x, y, 1, d)$; (b) planar homography induced by points all lying on a common plane $\hat{\mathbf{n}}_0 \cdot \mathbf{p} + c_0 = 0$.

Ex. 1010, Fig. 2.12 (annotated);
Petition at 47; (Cossairt) Ex. 1004, ¶114.

Border's various registrations teach "point of view" limitations for all images, even those with occlusions

> Even for three-dimensional scenes at closer range, Border teaches image registration methods (e.g., feature-based registration, registration using a true depth map) for providing an output image with no occlusion from the point of view of the first camera. APPL-1013, ¶36. For example, Border's feature-based registration was well-known to address artifacts (e.g., occlusion) when combining images from different point of views. *Id.*; *see e.g.,* APPL-1012, 183 (explaining "features [] can also be good indicator of [] occlusion events"), 194, Fig. 4.13 (below) (illustrating feature-based registration used to match two images taken from dramatically different viewpoints). Further, a POSITA would have also

Reply at 19; *see also* (Cossairt) Ex. 1013, ¶¶36, 37.

- **Use of depth maps:** (Border) Ex. 1006 at [0048], cited at Petition at 46.
- **Correction for tilt:** (Border) Ex. 1006 at [0041], cited in Reply at 6-7.
- **Feature-based techniques:** (Border) Ex. 1006 at [0042], cited at Petition at 46.

PO and its expert do not dispute that Border's homography teaches an output image without occlusion for planar scenes

Even though the '152 Patent does not so require (*see* IV.A.1), Border teaches techniques to provide an output image without artifacts (e.g., occlusion, parallax) that are possible for some images from different point of views. APPL-1013, ¶¶35-37. In fact, there is no dispute that for **planar scenes**, Border's homography registration teaches providing an output image without such artifacts. Response, 29; APPL-1011, 117-120 (Dr. Kosmach admitting that planar scenes do not have occlusion or parallax issues between two images). Indeed, as shown in

Reply at 18-19; *see also* (Cossairt) Ex. 1013, ¶¶35-37.

Q. Planar scenes do not have occlusion issues, correct?

MR. RUBIN: Objection. Form.

THE WITNESS: Between the two image, yes, that's -- that's correct.

(Kosmach Depo) Ex. 1011 at 117.

Border will have image data from both the telephoto and wide angle cameras. While there may not be any noticeable occlusions if the scene is planar, that does not mean that the output image has the point of view of one camera. It just means that one cannot, upon visible inspection, see that the output image has image data from both points of view. But Apple cannot dispute that when Border is used to photograph a

Sur-reply at 7.

PO chose not to dispute that Border teaches resolving occlusion

Instead, PO alleges that Petitioner's reliance on Border's various registrations are improper and untimely.

> Apple argues, for the first time, that Border discloses elements of the challenged claims because it purportedly teaches "various registration models" beyond pure translation and scaling homography, such as "feature-based registration, registration with true depth map, and registration correcting tilt." Reply, at 6-7; *see* 14, 19, and 24. Apple's arguments based on these three "registration models" are both improper and untimely.

Sur-reply at 12.

PO's allegation is incorrect.

> A POSITA would have understood that the composite image 208 that is generated by modifying the wide image 204 using the telephoto image 208 with registration information (e.g., represented by homography H_{TW}) that "transforms the coordinates of the telephoto image 206 **to** the wide image 204" has the same point of view as the wide image 204. (APPL-1006), Border, [0038]-[0040], [0042], [0048]; (APPL-1010), Szeliski, Fig. 2.12, 50-51; (APPL-1008), Jacobson, 5, 57-58; (APPL-1004), Cossairt, ¶114. Specifically, Dr. Cossairt confirms that it was well

Petition at 46.

Feature-based techniques:

> **[0042]** Alternatively, the registration between images can be determined using the image information contained in the wide image **204** and telephoto image **204**. This is well known in the art of image processing (for example, image registration is described in U.S. Pat. No. 6,078,701) and generally includes the steps of finding interest points in each image, making guesses at corresponding points (i.e. a scene feature that appears in both images), determining an initial guess at the registration, using that initial guess to refine the correspondence point guess, and so on based on comparing pixel values or contrast in the two images.

(Border) Ex. 1006 at [0042]

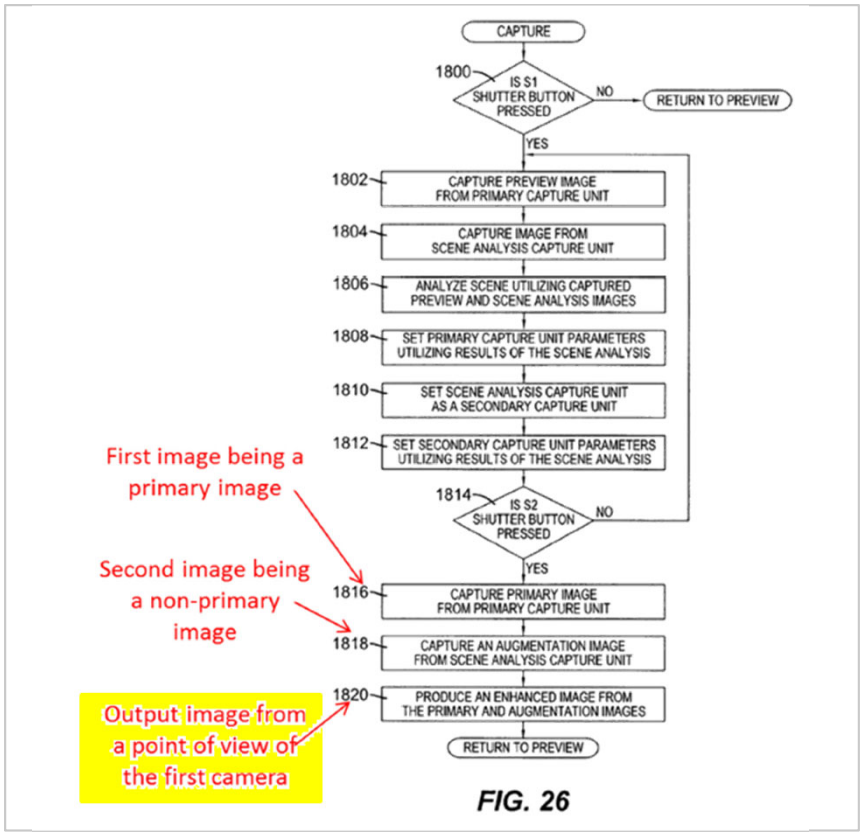
True depth map:

> wide image **204**. A true depth map can also be created and used by the image resampler **214** to sample the appropriate locations within the telephoto image **206** and the wide image **204**. In this case, the registration model is no longer a simple scale translation model.

(Border) Ex. 1006 at [0048]

Border and Parulski teach an output image from a point of view of the first camera

Not disputed that Parulski teaches output image from a point of view of the first camera:



(Parulski) Ex. 1007, Fig. 26 (annotated);
Petition at 51; *see also* Reply at 10;
(Cossairt) Ex. 1004 at 55.

[1.9] [processor configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}),] ***the first image being a primary image and the second image being a non-primary image,***

Border in combination with Parulski renders obvious that the processor is configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}), the first image being a primary image and the second image being a non-primary image. (APPL-1004), Cossairt, ¶¶116-123.

Petition at 48; *see also* (Cossairt) Ex. 1004, ¶¶116-123.

It would have been obvious to a POSITA that in the combination, when the zoom amount 210 Z is between 1 and M, the wide image 204 (first image) is primary image as Z is within the zoom range (e.g., from 1 to M) of the wide camera, and the telephoto image 206 (second image) is non-primary image, and the telephoto image 206 is used to modify the wide image 204 to generate a composite image 208 that is an enhanced primary image. (APPL-1006), Border, [0037], [0044], [0058]; (APPL-1007), Parulski, Figs. 15A, 15B, 16A, 16B, 23:28-40, 23:53-58; (APPL-1004), Cossairt, ¶122. A POSITA would have understood that such an enhanced primary image is from a point of view of the primary image, wide image 204 (the first image). (APPL-1004), Cossairt, ¶122; *see also* (APPL-1008), Jacobson, 5, 57-58 (explaining that "viewpoint is the centre of the pupil of the eye of the observer," and when a scene is captured by an imaging system, "the camera lens takes the place of the eye"); (APPL-1010), Szeliski, Fig. 2.12, 50-51.

Petition at 54; *see also* Reply at 20-22.

Discussion Summary

- Claim Construction
- Border and Parulski would have been combined
- Border and Parulski teach point of view limitations
- Border and Parulski teach primary/non-primary images limitations
- Border and Parulski teach an output image from a point of view of the second camera if $FOV_2 \geq FOV_{ZF}$

Claim 1 – primary/non-primary images limitations [1.9] and [1.11]

1. A multi-aperture imaging system comprising:

a) a first camera that provides a first image, the first camera having a first field of view (FOV_1) and a first sensor with a first plurality of sensor pixels covered at least in part with a standard color filter array (CFA);

b) a second camera that provides a second image, the second camera having a second field of view (FOV_2) such that $FOV_2<FOV_1$ and a second sensor with a second plurality of sensor pixels, the second plurality of sensor pixels being either Clear or covered with a standard CFA, the second image having an overlap area with the first image; and

c) a processor configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}), the first image being a primary image and the second image being a non-primary image, wherein if $FOV_2<FOV_{ZF}<FOV_1$ then the point of view of the output image is that of the first camera, the processor further configured to register the overlap area of the second image as non-primary image to the first image as primary image to obtain the output image.

('152 Patent, claim 1) Ex. 1001, 12:60-13:13.

Undisputed that Parulski teaches obtaining the output image using primary/non-primary images

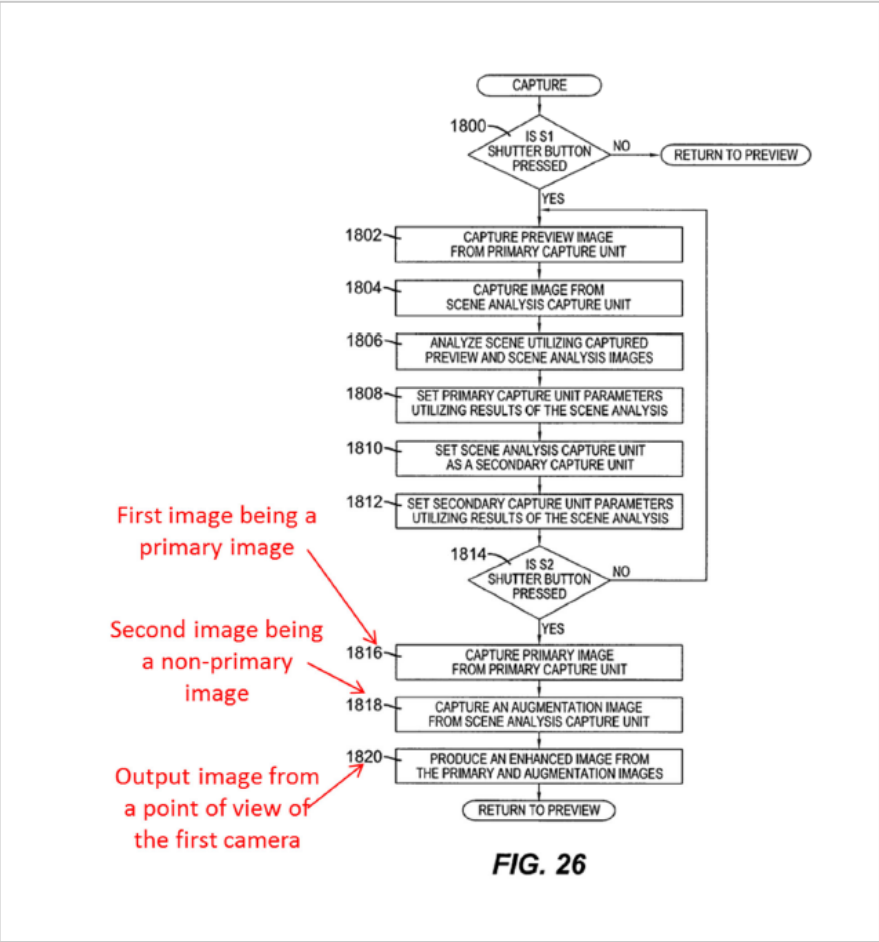


FIG. 26

(Parulski) Ex. 1007, Fig. 26, annotated; Petition at 51; Reply at 10.

Border teaches "register the overlap area"

Third, Border teaches that its processor 50 registers the overlap area of the telephoto image 206 (second image), which is the entire area of telephoto image 206, to the wide image 204 (first image). (APPL-1004), Cossairt, ¶134. As explained above in [1.8], in registering telephoto image 206 to wide image 204, a POSITA would have understood that Border establishes a primary/non-primary relationship between first image and second image as claimed, though without express usage of the "primary image" and "non-primary image" labels. (APPL-1004), Cossairt, ¶134. However, Parulski, in an analogous context, uses the labels "primary image" and "secondary image" to describe the roles of respective images used in forming a composite image. (APPL-1007), Parulski, 7:32-35, 7:54-8:5; (APPL-1004), Cossairt, ¶134. Note that Parulski expressly incorporates Border and its teachings as an example of how Parulski's augmentation process may be applied to combining a wide angle image and a telephoto image. (APPL-1007), Parulski, 29:51-67; (APPL-1004), Cossairt, ¶134.

Petition at 57-58; *see also* Reply at 23-25.

PO seeks to import two unsupported and extraneous "predicates" into the term "register"

The '152 Patent explains that its "registration process considers the primary image as the baseline image and registers the overlap area in the auxiliary image to it" by finding corresponding pixels in the overlap area between the primary image and the auxiliary image. Ex. 1001, at 9:22-27. This species of image registration requires two predicates: (1) different portions of the overlap region between the Wide and Tele images are treated differently based on differences of the relative positions and shapes of objects in the two images, meaning that pixels of one image cannot be simply translated to those of another image; and (2) identification of the primary image is necessary since the registration process must identify which objects (and pixels) must be included in the output image and which objects (and pixels) do not. Kosmach Decl., ¶40. Both of these predicates are required for a system to generate an output image that has the point of view of only one of the input images.

Response at 27-28.

Unsupported and Extraneous Predicates

Reply at 22-23.

No Explanation

Reply at 23.

PO's unsupported and extraneous predicates of "register" should be rejected

First, Patent Owner's importation of those two predicates (Response, 27) to the partial limitation of [1.11] is premised upon the improperly imported requirements (e.g., an output image without occlusion) to the "*the point of view of the output image is that of the first camera*" of [1.10], and as such, should be rejected for at least the same reasons as discussed above at IV.A.1 with respect to requirements improperly imported into [1.10]. APPL-1013, ¶41.

Second, Patent Owner extensively relies on description of primary/auxiliary image relationship in the '152 Patent to support its predicates. Response, 26. However, Patent Owner and its expert witness do not provide any explanation for deriving the two predicates from that primary/auxiliary image relationship. Dr. Cossairt confirms that those two predicates do not follow from the description of the '152 Patent. APPL-1013, ¶42. Further, such additional requirements are inconsistent with the Patent Owner's proposed construction in the corresponding District Court proceeding which does not include the predicates. Ex.2007, 16. As such, the predicates are unsupported, extraneous, and should be rejected.

Premised on improperly imported requirements (no occlusion)

PO's evidence not credible

Petitioner's expert rebuts

Inconsistent with PO's express construction in District Court

Reply at 22-23.

Discussion Summary

- Claim Construction
- Border and Parulski would have been combined
- Border and Parulski teach point of view limitations
- Border and Parulski teach primary/non-primary images limitations
- Border and Parulski teach an output image from a point of view of the second camera if $FOV_2 \geq FOV_{ZF}$

Claim 2: an output image from a point of view of the second camera if $FOV_2 \geq FOV_{ZF}$

2. The multi-aperture imaging system of claim **1**, wherein, if $FOV_2 \geq FOV_{ZF}$, then the processor is further configured to provide an output image from a point of view of the second camera.

Undisputed that Border teaches an output image from a point of view of the second camera when $FOV_2=FOV_{ZF}$

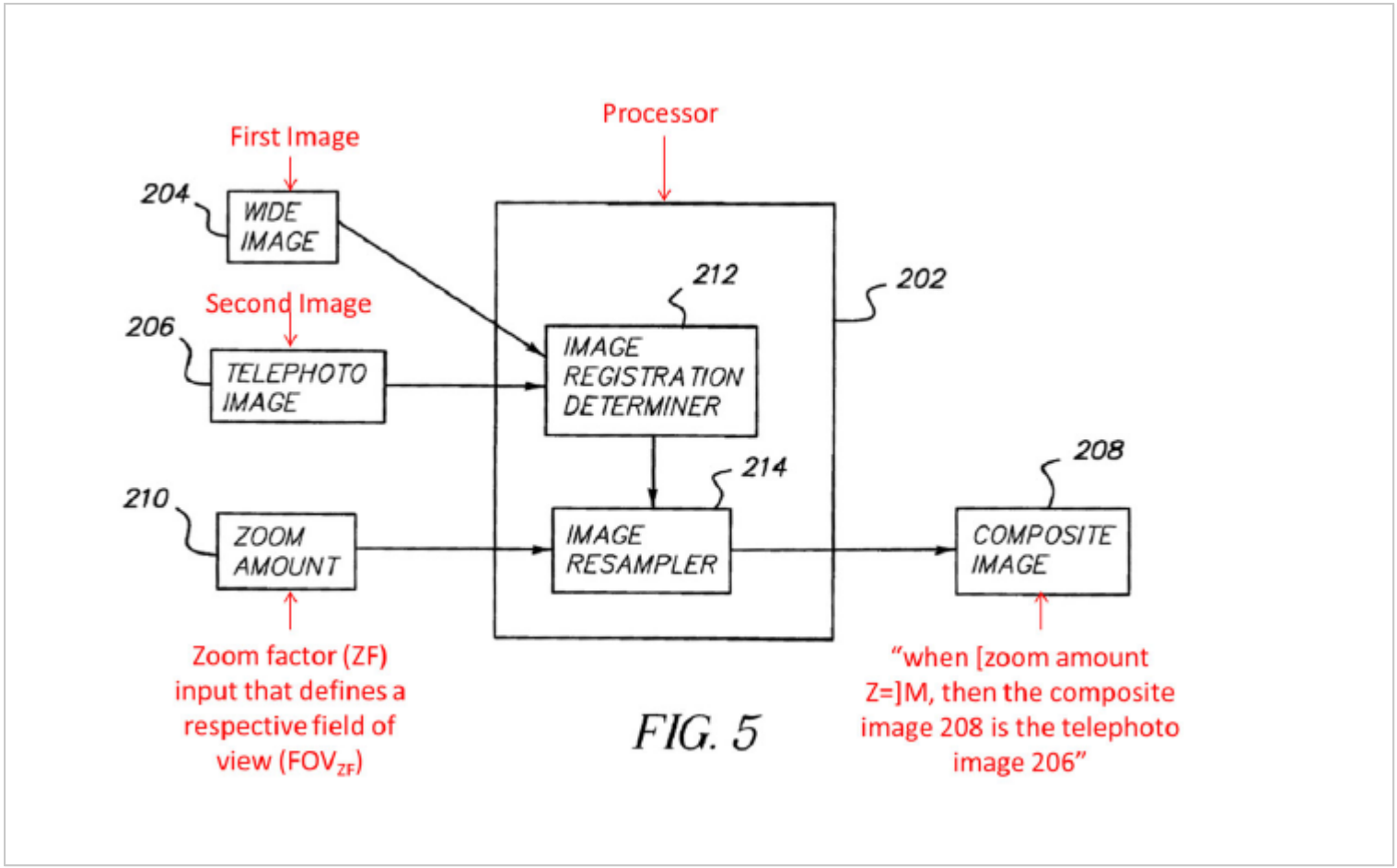


FIG. 5

(Border) Ex.1006, Fig. 5, annotated; Petition at 65;
(Cossairt) Ex.1004 at 70.

Patent Owner's arguments that $FOV_2 \geq FOV_{ZF}$ requires $FOV_2 = FOV_{ZF}$ **and** $FOV_2 > FOV_{ZF}$ are incorrect

> Thus, because Border does not teach an "output image from a point of view of the second camera" where $FOV_2 > FOV_{ZF}$, or for that matter, any disclosure "where FOV_2 is greater than FOV_{ZF}", Apple has not provided legally sufficient support to show any disclosure of this limitation in the prior art.

Response at 35-36.

Patent Owner's understanding of $FOV_2 \geq FOV_{ZF}$ is mathematically incorrect.

> Pet.64-65. Patent Owner incorrectly asserts that Border does not disclose this limitation because "Border does not teach an 'output image from a point of view of the second camera' where $FOV_2 > FOV_{ZF}$." Response, 34. Patent Owner's understanding of $FOV_2 \geqq FOV_{ZF}$ is mathematically incorrect, because $FOV_2 \geqq FOV_{ZF}$ is satisfied by either $FOV_2 > FOV_{ZF}$ **or** $FOV_2 = FOV_{ZF}$. APPL-1013, ¶52. In fact, Patent Owner's expert, Dr. Kosmach stated that claim 2 requires "greater than or equal." APPL-1011, 84-85. As such, Border does not need to

Reply at 27.

Border and Parulski teach "$FOV_2 \geq FOV_{ZF}$" even under PO's construction

As explained in Petition, Parulski teaches that if the requested zoom position is not within the zoom range of the current primary capture unit, "the functions of the capture units are reversed" by switching the primary/secondary capture units. Pet.17-18, 51-53; *see also* APPL-1007, Fig. 23, Fig. 14, 22:18-21 ("In block 502, the zoom position setting is **compared to a value X** at which the image capture function **switches**" between first/second image capture units); APPL-1013, ¶55. Block 530 of Fig. 14 shows second image capture unit as primary when $FOV_2 > FOV_{ZF}$ (for branch at Block 502 where "zoom position>X"). As such, a POSITA would have understood that a transition that occurs at the $FOV_2 = FOV_{ZF}$ transition point (X) persists for $FOV_2 > FOV_{ZF}$. APPL-1013, ¶55.

...

A POSITA would have been motivated to apply Parulski's reversing the primary/secondary capture units to Border, such that in the combination, under both $FOV_2 = FOV_{ZF}$ **and** $FOV_2 > FOV_{ZF}$, the primary image is the telephoto image which has a higher resolution than the wide image, and the output image has the point of view of the second camera (telephoto image as primary image). APPL-1013, ¶56.

Reply at 28-29.

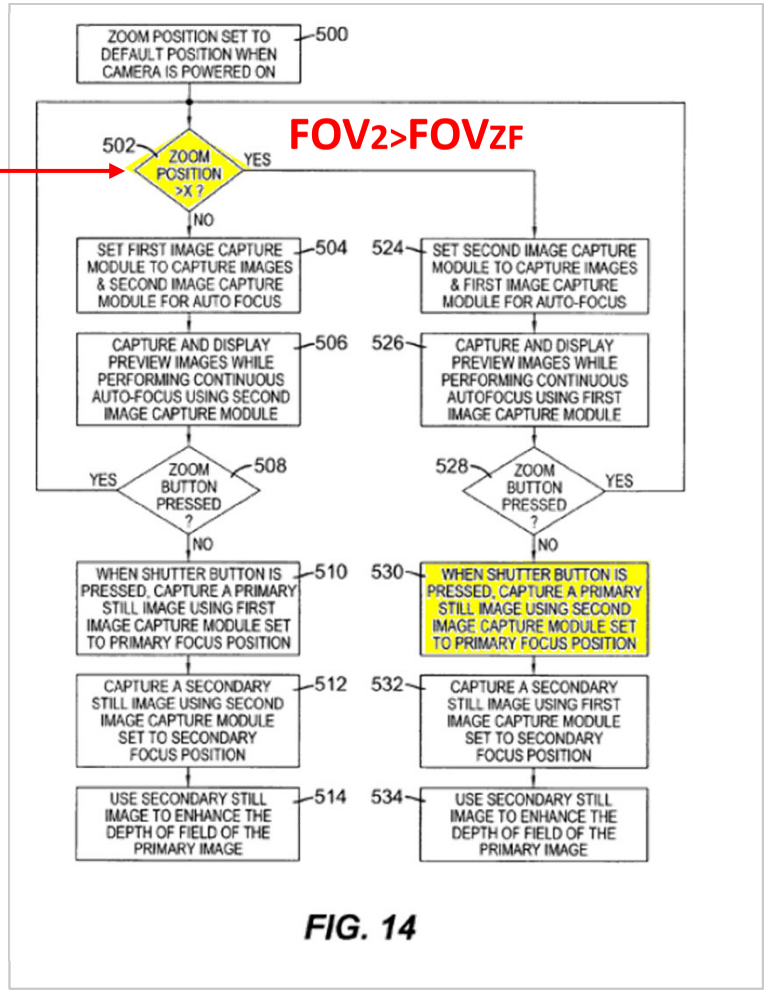


FIG. 14

(Parulski) Ex. 1007, FIG. 14; Petition, 17-18, 51-53; Reply at 29.

Further Questions?

APPENDIX

Overview: ’152 Patent

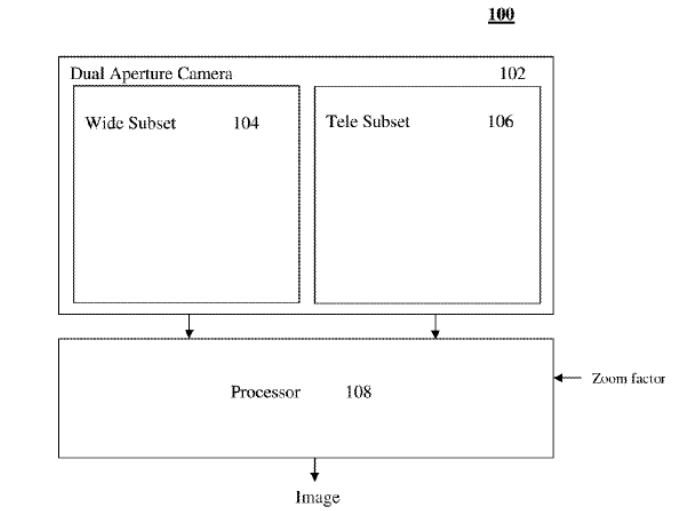


FIG. 1A

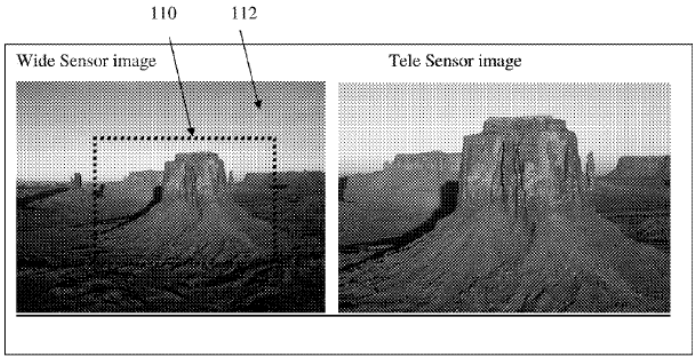


FIG. 1B

(’152 Patent) Ex.1001, FIGS. 1A and 1B

Overview: ’152 Patent

1. A multi-aperture imaging system comprising:

a) a first camera that provides a first image, the first camera having a first field of view (FOV_1) and a first sensor with a first plurality of sensor pixels covered at least in part with a standard color filter array (CFA);

b) a second camera that provides a second image, the second camera having a second field of view (FOV_2) such that $FOV_2<FOV_1$ and a second sensor with a second plurality of sensor pixels, the second plurality of sensor pixels being either Clear or covered with a standard CFA, the second image having an overlap area with the first image; and

c) a processor configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}), the first image being a primary image and the second image being a non-primary image, wherein if $FOV_2<FOV_{ZF}<FOV_1$ then the point of view of the output image is that of the first camera, the processor further configured to register the overlap area of the second image as non-primary image to the first image as primary image to obtain the output image.

(’152 Patent) Ex.1001, 12:60-13:13.

Claim construction – "standard color filter array (CFA)"

Corephotonics' Proposed Construction	Apple's Proposed Construction
a color filter array (CFA) that includes a RGB (Bayer) pattern or a non-Bayer pattern such as RGBE, CYYM, CYGM, RGBW#1, RGBW#2 or RGBW#3	a color filter array (CFA) including a RGB (Bayer) pattern, RGBE, CYYM, CYGM, RGBW#1, RGBW#2, or RGBW#3

Response at 11.

CFA may cover the entire Wide sensor area. A "standard CFA" may include a RGB (Bayer) pattern or a non-Bayer pattern such as RGBE, CYYM, CYGM, RGBW#1, RGBW#2 or RGBW#3. Thus, reference may be made to "standard Bayer" or "standard non-Bayer" patterns or filters. As used herein, "non-standard CFA" refers to a CFA that is different in its pattern that CFAs listed above as "standard".

('152 Patent) Ex.1001, 2:43-49, cited in Petition at 10-11.

Claim construction – "point of view"

Sur-Reply's reliance on '291 Patent is misleading:

point of view), of only one of the multiple cameras. The inventors of the '152 patent explained that a composite output image that combines data from two cameras could have the point of view of either camera, or a combination of both:

> In a dual-aperture camera image plane, as seen by each sub-camera (and respective image sensor), a given object will be shifted and have different perspective (shape). This is referred to as point-of-view (POV). The system output image can have the shape and position of either sub-camera image **or the shape or position of a combination thereof**.

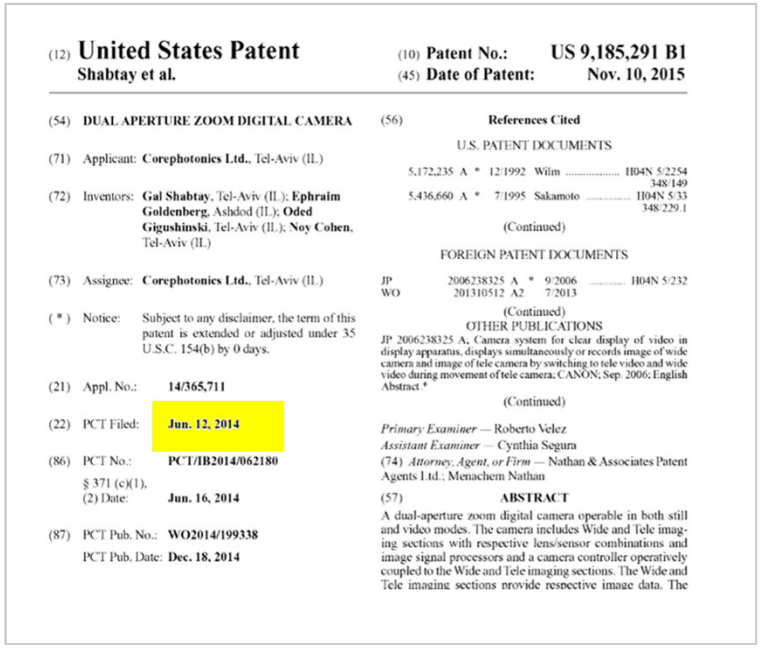
Ex. 2009, at 4:60-4:65. While the '152 patent's inventors understood that a

Sur-reply at 5.

As previously explained, construing "point of view" to mean "camera angle" is consistent with the intrinsic evidence and the inventors' usage of the that term. Apple's construction, "viewpoint," lacks any support in the specification of the '152 patent (or the '291 patent) and also suffers from inconsistent and indeterminate scope when used by Apple and its expert. *See* POR, at 13-16.

Sur-reply at 2.

'291 Patent was filed <u>after</u> the priority date of the '152 patent:



(12) **United States Patent**
Shabtay et al.

(10) **Patent No.: US 9,185,291 B1**
(45) **Date of Patent: Nov. 10, 2015**

(54) **DUAL APERTURE ZOOM DIGITAL CAMERA**

(71) Applicant: **Corephotonics Ltd.**, Tel-Aviv (IL)

(72) Inventors: **Gal Shabtay**, Tel-Aviv (IL); **Ephraim Goldenberg**, Ashdod (IL); **Oded Gigushinski**, Tel-Aviv (IL); **Noy Cohen**, Tel-Aviv (IL)

(73) Assignee: **Corephotonics Ltd.**, Tel-Aviv (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/365,711**

(22) PCT Filed: **Jun. 12, 2014**

(86) PCT No.: **PCT/IB2014/062180**
§ 371 (c)(1),
(2) Date: **Jun. 16, 2014**

(87) PCT Pub. No.: **WO2014/199338**
PCT Pub. Date: **Dec. 18, 2014**

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(Continued)

Primary Examiner — Roberto Velez
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(74) *Attorney, Agent, or Firm* — Nathan & Associates Patent Agents Ltd.; Menachem Nathan

(57) **ABSTRACT**

A dual-aperture zoom digital camera operable in both still and video modes. The camera includes Wide and Tele imaging sections with respective lens/sensor combinations and image signal processors and a camera controller operatively coupled to the Wide and Tele imaging sections. The Wide and Tele imaging sections provide respective image data. The

Ex. 2009 at 1.

Undisputed that Border teaches claim 1 preamble: a multi-aperture imaging system

[0059] A number of advantages can be obtained by use of the fixed focal length lenses in digital camera **10**B. The aperture of each lens can be kept quite large (e.g., f/2.8 at least for the widest angle lens), thereby providing a high speed, low light lens. In addition, the image quality of the optical assembly can be kept higher and at a lower manufacturing cost than for a comparable zoom lens. When digital zooming is employed, there are no moving parts for the zoom—even though there are multiple zoom settings—and the zoom is completely silent and relatively fast in zoom focal length transitions. In addition, the overall size of the image module including both fixed focus lenses and both image sensors is very compact which makes this embodiment important for cell phone cameras and other applications in which size is critical.

(Border) Ex.1006, [0059]; Petition at 22.

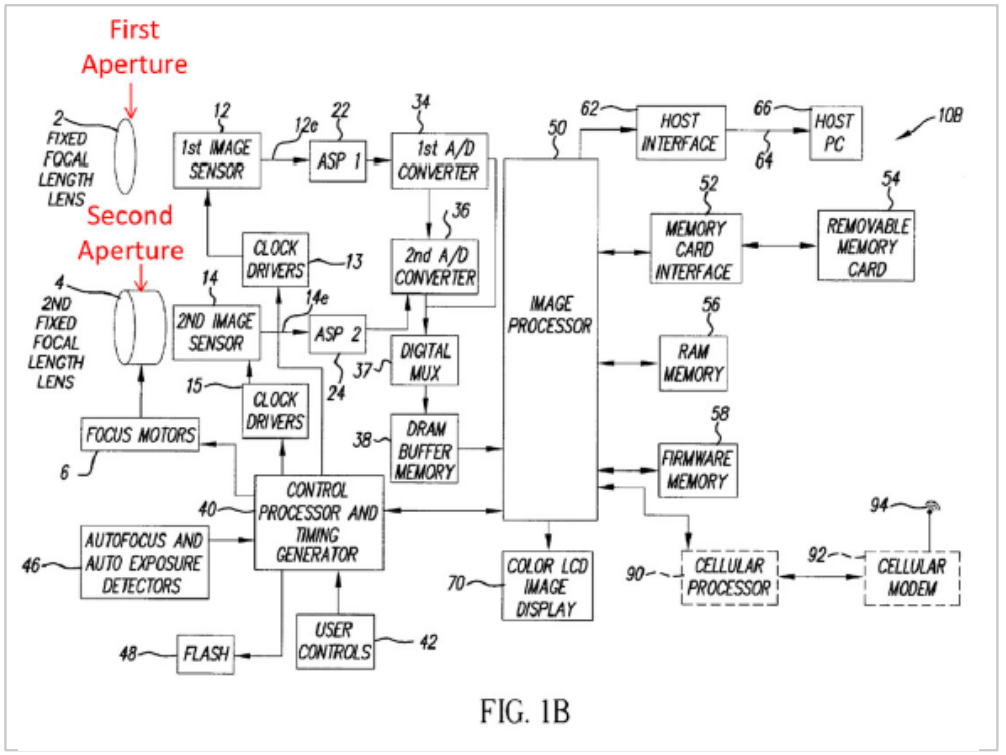


FIG. 1B

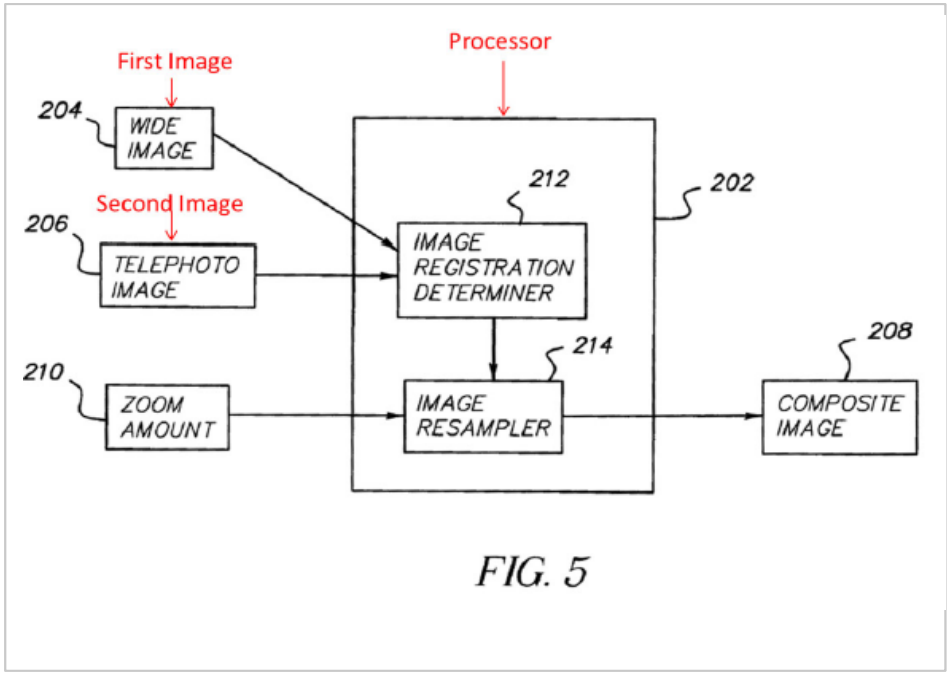
(Border) Ex.1006, Fig. 1B, annotated; Petition at 22.

Undisputed that Border teaches claim 1 elements (a) and (b)

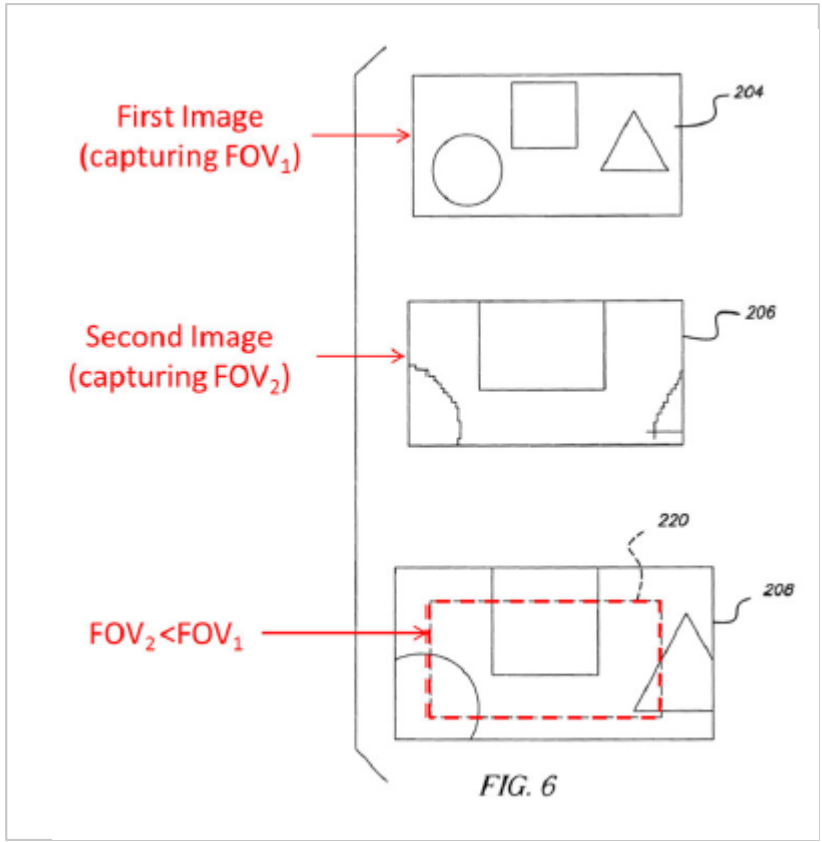
1. A multi-aperture imaging system comprising:
a) a first camera that provides a first image, the first camera having a first field of view (FOV_1) and a first sensor with a first plurality of sensor pixels covered at least in part with a standard color filter array (CFA);
b) a second camera that provides a second image, the second camera having a second field of view (FOV_2) such that $FOV_2<FOV_1$ and a second sensor with a second plurality of sensor pixels, the second plurality of sensor pixels being either Clear or covered with a standard CFA, the second image having an overlap area with the first image; and

('152 Patent, claim 1) Ex. 1001, 12:60-13:4.

Undisputed that Border teaches claim 1 elements (a) and (b)



(Border) Ex.1006, Fig. 5, annotated; Petition at 30.



(Border) Ex.1006, Fig. 6, annotated; Petition at 35.

Record explains that Border teaches various registration models

Border, [0038]-[0039]. Border also explains that another way for registration between images is to use "image information contained in the wide image 204 and telephoto image 204" that "is well known in the art of image processing." (APPL-1006), Border, [0042]. Border further provides that registration models other than "a simple scale translation model" may also be used (e.g., with a true depth map) to reduce a "discontinuity artifact." (APPL-1006), Border, [0048].

(Cossairt) Ex. 1004, ¶112, cited in Petition at 46.

wide image **204**. A true depth map can also be created and used by the image resampler **214** to sample the appropriate locations within the telephoto image **206** and the wide image **204**. In this case, the registration model is no longer a simple scale translation model.

(Border) Ex. 1006 at [0048], cited at Petition at 46.

[0041] The correspondences between the coordinate systems represent the registration between the wide image **204** and the telephoto image **206**. The correspondences are preferably determined at the time of manufacture by shooting test targets, as is well known in the art. If one or both of the lenses were a zoom lens rather than a fixed lens., the registration correspondences could still be determined at the time of manufacture as a function of the zoom position of the lenses. It should be further noted that while the example shows a pure translate and scale transformation, it may be necessary to correct for a difference in tilt between the two imaging systems.

(Border) Ex. 1006 at [0041], cited in Reply at 6-7.

[0042] Alternatively, the registration between images can be determined using the image information contained in the wide image **204** and telephoto image **204**. This is well known in the art of image processing (for example, image registration is described in U.S. Pat. No. 6,078,701) and generally includes the steps of finding interest points in each image, making guesses at corresponding points (i.e. a scene feature that appears in both images), determining an initial guess at the registration, using that initial guess to refine the correspondence point guess, and so on based on comparing pixel values or contrast in the two images.

(Border) Ex. 1006 at [0042], cited at Petition at 46.

The Petition's Border in view of Parulski Analysis of [1.9] includes [1.8]

[1.8] ***c) a processor configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}),***

Border teaches a processor configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}). (APPL-1004), Cossairt, ¶¶101-115.

Petition at 39-40.

[1.9] [processor configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}),] ***the first image being a primary image and the second image being a non-primary image,***

Border in combination with Parulski renders obvious that the processor is configured to provide an output image from a point of view of the first camera based on a zoom factor (ZF) input that defines a respective field of view (FOV_{ZF}), the first image being a primary image and the second image being a non-primary image. (APPL-1004), Cossairt, ¶¶116-123.

Petition at 48.

PO construction in district court belies its unsupported and extraneous "predicates"

C. **"to register the overlap area of the second image as non-primary image to the first image as primary image to obtain the output image" (proposed by Corephotonics) / "register the overlap area of the second image as non-primary image to the first image as primary image" (proposed by Apple) (*'152 patent, claims 1, 3*)[2]**

Corephotonics' Proposed Construction	Apple's Proposed Construction
to map the overlap area of the second image as the non-primary image to first image as the primary image, finding correspondences between the pixels in the two images for the overlap area, to form the output image using information from the non-primary and primary images together with the mapping information of the non-primary image to the primary image for the overlap area	map the overlap area of the second image as the non-primary image to the first image as the primary image, by finding correspondences between the pixels in the two images for the overlap area Apple proposes that the phrase requiring construction is provided in term 3 above, and "to obtain the output image" is an objective of the claimed registration and is not a limitation requiring construction

Ex. 2007 at 16, cited in Reply at 23.