

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ALIGN TECHNOLOGY, INC.
Petitioner

v.

3SHAPE A/S
Patent Owner

Case No. PGR2018-00103
Patent 9,962,244

**SECOND CORRECTED PETITION FOR POST-GRANT REVIEW
OF U.S. PATENT NO. 9,962,244**

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Patent Trial and Appeal Board
U.S. Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

TABLE OF CONTENTS

| | | |
|------|--|----|
| I. | Introduction..... | 1 |
| II. | Identification of challenge (37 C.F.R. § 42. 204(b))..... | 2 |
| A. | Identification of challenge and statement of relief requested | 2 |
| B. | The Board should institute all of Petitioner’s proceedings filed against the ’244 Patent to not unjustly prevent Petitioner from challenging the ’244 Patent.. | 5 |
| III. | The Board should institute trial notwithstanding 35 U.S.C. § 325(d) because all of the factors considered in the § 325(d) analysis weigh in favor of institution. | 7 |
| IV. | The ’244 Patent..... | 11 |
| A. | Overview of the ’244 Patent..... | 11 |
| B. | Prosecution History | 16 |
| V. | POSITA | 17 |
| VI. | Claims 19, 25, and 32 lack support in the Provisional Application requiring PGR eligibility..... | 17 |
| A. | Claims 19 and 32..... | 17 |
| B. | Claim 25 | 19 |
| VII. | Grounds 1 and 2: The combinations of Fisker and Szeliski (Ground 1) and Fisker and Matsumoto (Ground 2) render claims 1-5, 7-10, 15, 16, 18, 21, 22, 24, 26, and 28 obvious..... | 21 |
| A. | Claim 1 | 21 |
| 1. | [1.P]: “A focus scanner for recording surface geometry and surface color of an object” | 21 |
| 2. | [1.1]: “a multichromatic light source configured for providing a multichromatic probe light for illumination of the object”..... | 22 |
| 3. | [1.2]: “a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from said object” | 23 |
| 4. | [1.3.a]: “wherein the focus scanner is configured to operate by translating a focus plane along an optical axis of the focus scanner”..... | 23 |
| 5. | [1.3.b]: “wherein the focus scanner is configured to operate by...capturing a series of the 2D images, each 2D image of the series is at a | |

| | |
|---|----|
| different focus plane position such that the series of captured 2D images forms a stack of 2D images” | 24 |
| 6. [1.4.a]: “a data processing system configured to derive surface geometry information for a block of said image sensor pixels from the 2D images in the stack of 2D images captured by said color image sensor” | 25 |
| 7. [1.4.b]: “the data processing system also configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information” | 26 |
| 8. [1.5.a]: “wherein the data processing system further is configured to combining [sic] a number of sub-scans to generate a digital 3D representation of the object, and” | 28 |
| 9. [1.5.b]: “determining [sic] object color of at least one point of the generated digital 3D representation of the object from sub-scan color of the sub-scans combined to generate the digital 3D representation” | 29 |
| 10. [1.5.c]: “such that the digital 3D representation expresses both geometry and color profile of the object” | 30 |
| 11. [1.6]: “wherein determining the object color comprises computing a weighted average of sub-scan color values derived for corresponding points in overlapping sub-scans at that point of the object surface.” | 31 |
| a) Fisker | 31 |
| b) Szeliski (Ground 1) | 32 |
| c) Matsumoto (Ground 2) | 34 |
| d) Motivation to Combine: Fisker and Szeliski (Ground 1) and Fisker and Matsumoto (Ground 2) | 37 |
| B. Claim 2: “The focus scanner according to claim 1, wherein the data processing system is configured for generating a sub-scan of a part of the object surface based on surface geometry information and surface color information derived from a plurality of blocks of image sensor pixels.” | 44 |
| C. Claim 3: “The focus scanner according to claim 1, where the scanner system comprises a pattern generating element configured for incorporating a spatial pattern in said probe light.” | 44 |
| D. Claim 4: “The focus scanner according to claim 1, where deriving the surface geometry information and surface color information comprises calculating for several 2D images a correlation measure between the portion of | |

the 2D image captured by said block of image sensor pixels and a weight function, where the weight function is determined based on information of the configuration of the spatial pattern.”45

E. Claim 5: “The focus scanner according to claim 4, wherein deriving the surface geometry information and the surface color information for a block of image sensor pixels comprises identifying the position along the optical axis at which the corresponding correlation measure has a maximum value.”47

F. Claim 7: “The focus scanner according to claim 6, where the maximum correlation measure value is the highest calculated correlation measure value for the block of image sensor pixels and/or the highest maximum value of the correlation measure function for the block of image sensor pixels.”48

G. Claim 8: “The focus scanner according to claim 5, wherein the data processing system is configured for determining a sub-scan color for a point on a generated sub-scan based on the surface color information of the 2D image in the series in which the correlation measure has its maximum value for the corresponding block of image sensor pixels.”48

H. Claim 9: “The focus scanner according to claim 8, wherein the data processing system is configured for deriving the sub-scan color for a point on a generated sub-scan based on the surface color information of the 2D images in the series in which the correlation measure has its maximum value for the corresponding block of image sensor pixels and on at least one additional 2D image.”50

I. Claim 10: “The focus scanner according to claim 9, where the data processing system is configured for interpolating surface color information of at least two 2D images in a series when determining the sub-scan color.”51

J. Claim 15: “The focus scanner according to claim 1, where the color image sensor comprises a color filter array comprising at least three types of colors filters, each allowing light in a known wavelength range, W1, W2, and W3 respectively, to propagate through the color filter.”51

K. Claim 16: “The focus scanner according to claim 15, where the surface geometry information is derived from light in a selected wavelength range of the spectrum provided by the multichromatic light source.”52

L. Claim 18: “The focus scanner according to claim 16, wherein the selected wavelength range matches the W2 wavelength range.”53

M. Claim 21: “The focus scanner according to claim 3, where the information of the saturated pixel in the computing of the pattern generating element is

| | |
|---|----|
| configured to provide that the spatial pattern comprises alternating dark and bright regions arranged in a checkerboard pattern.” | 54 |
| N. Claim 22 | 55 |
| 1. [22.P]: “A method of recording surface geometry and surface color of an object” | 55 |
| 2. [22.1]: “obtaining a focus scanner according to claim 1” | 55 |
| 3. Limitations [22.2]-[22.4] | 56 |
| O. Claim 24: “The focus scanner according to claim 1, wherein the multichromatic light source, the color image sensor, and at least a portion of the data processing system are included in a hand held unit.” | 56 |
| P. Claim 26: “The focus scanner according to claim 9, wherein said at least one additional 2D image comprises a neighboring 2D image from the series of captured 2D images.” | 57 |
| Q. Claim 28: “The focus scanner according to claim 10, where the interpolation is of surface color information of neighboring 2D images in a series.” | 58 |
| VIII. Grounds 3 and 4: The combinations of Fisker and Yamada (Ground 3) and Fisker and Suzuki (Ground 4) render claim 29 obvious. | 58 |
| A. Claim 29 | 58 |
| 1. Limitations [29.P]-[29.4.b]: | 58 |
| 2. [29.5]: “where the data processing system further is configured to detecting (sic) saturated pixels in the captured 2D images and for mitigating or removing the error in the derived surface color information or the sub-scan color caused by the pixel saturation.” | 59 |
| a) Fisker | 59 |
| b) Yamada (Ground 3) | 60 |
| c) Suzuki (Ground 4) | 61 |
| d) Motivation to Combine: Fisker and Yamada (Ground 3) and Fisker and Suzuki (Ground 4) | 62 |
| IX. Grounds 5-8: The combinations of Fisker, Szeliski, and Yamada (Ground 5), Fisker, Szeliski, Suzuki (Ground 6), Fisker, Matsumoto, and Yamada (Ground 7), and Fisker, Matsumoto, and Suzuki (Ground 8) render claim 12 obvious..... | 66 |

| | | |
|----|---|----|
| A. | Claim 12: “The focus scanner according to claim 1, wherein the data processing system is configured for detecting saturated pixels in the captured 2D images and for mitigating or removing the error in the derived surface color information or the sub-scan color caused by the pixel saturation.” | 66 |
| X. | Grounds 9 and 10: The combinations of Thiel425, Thiel576, and Szeliski (Ground 9) and Thiel425, Thiel576, and Matsumoto (Ground 10) render claims 1, 22, and 24 obvious. | 67 |
| A. | Claim 1 | 67 |
| 1. | [1.P]: “A focus scanner for recording surface geometry and surface color of an object” | 67 |
| a) | Thiel425 | 67 |
| b) | Thiel576 | 68 |
| c) | Motivation to Combine: Thiel425 and Thiel576 | 69 |
| 2. | [1.1]: “a multichromatic light source configured for providing a multichromatic probe light for illumination of the object” | 72 |
| 3. | [1.2]: “a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from said object” | 73 |
| 4. | [1.3.a]: “wherein the focus scanner is configured to operate by translating a focus plane along an optical axis of the focus scanner” | 74 |
| 5. | [1.3.b]: “wherein the focus scanner is configured to operate by...capturing a series of the 2D images, each 2D image of the series is at a different focus plane position such that the series of captured 2D images forms a stack of 2D images” | 74 |
| 6. | [1.4.a]: “a data processing system configured to derive surface geometry information for a block of said image sensor pixels from the 2D images in the stack of 2D images captured by said color image sensor” | 75 |
| 7. | [1.4.b]: “the data processing system also configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information” | 76 |
| a) | Thiel425 | 76 |
| b) | Thiel576 | 76 |
| c) | Motivation to Combine: Thiel425 and Thiel576 | 77 |

| | | |
|-----|--|----|
| 8. | [1.5.a]: “wherein the data processing system further is configured to combining [sic] a number of sub-scans to generate a digital 3D representation of the object” | 79 |
| 9. | [1.5.b]: “wherein the data processing system further is configured to ... determining [sic] object color of a least one point of the generated digital 3D representation of the object from sub-scan color of the sub-scans combined to generate the digital 3D representation, such that the digital 3D representation expresses both geometry and color profile of the object” | 80 |
| 10. | [1.6]: “wherein determining the object color comprises computing a weighted average of sub-scan color values derived for corresponding points in overlapping sub-scans at that point of the object surface.” | 81 |
| a) | Thiel425/Thiel576..... | 81 |
| b) | Szeliski (Ground 9) and Matsumoto (Ground 10)..... | 81 |
| c) | Motivation to Combine: Thiel425, Thiel576, Szeliski (Ground 9) and Thiel425, Thiel576, Matsumoto (Ground 10) | 82 |
| B. | Claim 22 | 86 |
| 1. | [22.P]: “A method of recording surface geometry and surface color of an object” | 86 |
| 2. | [22.1]: “obtaining a focus scanner according to claim 1” | 86 |
| 3. | Limitations [22.2]-[22.4]..... | 87 |
| C. | Claim 24: “The focus scanner according to claim 1, wherein the multichromatic light source, the color image sensor, and at least a portion of the data processing system are included in a hand held unit.” | 87 |
| XI. | Grounds 11 and 12: The combinations of Thiel425, Thiel576, and Yamada (Ground 11) and Thiel425, Thiel576, and Suzuki (Ground 12) render claim 29 obvious..... | 88 |
| A. | Claim 29 | 88 |
| 1. | Limitations [29.P]-[29.4.b]..... | 88 |
| 2. | [29.5]: “where the data processing system further is configured to detecting (sic) saturated pixels in the captured 2D images and for mitigating or removing the error in the derived surface color information or the sub-scan color caused by the pixel saturation.” | 88 |
| a) | Thiel425/Thiel576..... | 88 |

| | | |
|-------|---|----|
| b) | Yamada (Ground 11) and Suzuki (Ground 12) | 89 |
| c) | Motivation to Combine: Thiel425, Thiel576, and Yamada (Ground 11) and Thiel425, Thiel576, and Suzuki (Ground 12)..... | 89 |
| XII. | Grounds 13 and 14: The combinations of Thiel425, Thiel576, Szeliski, and Fisker (Ground 13) and Thiel425, Thiel576, Matsumoto, and Fisker (Ground 14) render claims 2-5, 7-10, 15, 16, 18 , 21, 26, and 28 obvious..... | 92 |
| A. | Claims 2-5, 7-10, 15, 16, 18, 21, 26, and 28 | 92 |
| a) | Thiel425/Thiel576/Szeliski and Thiel425/Thiel576/Matsumoto | 92 |
| b) | Fisker..... | 92 |
| c) | Motivation to Combine: Thiel425, Thiel576, Szeliski and Fisker (Ground 13) and Thiel425, Thiel576, Matsumoto and Fisker (Ground 14) . | 93 |
| XIII. | Mandatory Notices (37 C.F.R. §42.8(a)(1)) | 96 |
| XIV. | Conclusion | 97 |

EXHIBIT LIST

| Exhibit | Description |
|----------------|---|
| 1001 | U.S. Patent No. 9,962,244 to Esbech et al. (“the ’244 patent”) |
| 1002 | Prosecution File History for the ’244 patent (“’244 patent file history”) |
| 1003 | Declaration of Dr. Chandra Bajaj, Ph.D. (“Bajaj Decl.”) |
| 1004 | Curriculum vitae of Dr. Chandra Bajaj, Ph.D. |
| 1005 | U.S. Patent Application Publication No. 2012/0092461 to Fisker et al. (filed June 17, 2009; published: April 19, 2012) |
| 1006 | U.S. Patent No. 6,097,854 to Szeliski et al. (filed August 1, 1997; issued August 1, 2000) |
| 1007 | U.S. Patent No. 7,106,348 B2 to Matsumoto et al. (filed November 28, 2001; issued: September 12, 2006) |
| 1008 | U.S. Patent Application Publication No. 2007/0035641 to Yamada et al. (filed April 25, 2005; published: February 15, 2007) |
| 1009 | U.S. Patent Application Publication No. 2013/0070128 to Suzuki et al. (filed September 10, 2012; published March 21, 2013) |
| 1010 | U.S. Patent Application Publication No. 2015/0029367 to Tanaka (earliest priority date July 29, 2011; published January 29, 2015) |
| 1011 | U.S. Patent Application Publication No. US 2010/0067789 to Cai (filed September 18, 2011; published March 18, 2010) |
| 1012 | U.S. Patent Application Publication No. 2012/0075425 to Thiel (“Thiel425”) (filed August 19, 2011; published: March 29, 2012) |
| 1013 | U.S. Patent Application Publication No. 2011/0080576 to Thiel et al. (“Thiel576”) (filed October 1, 2010; published: April 7, 2011) |
| 1014 | Agini, Andreas, et al. <i>Digital Dental Revolution: The Learning Curve</i> . Quintessence Publishing, First edition, 2015. |

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| Exhibit | Description |
|----------------|--|
| 1015 | U.S. Patent No. 6,750,873 to Bernardini et al. (“Bernardini”) (filed June 27, 2000; issued June 15, 2004). |
| 1016 | U.S. Patent Application Publication No. 2013/0101176 to Park et al. (“Park”) (filed August 24, 2012; published April 25, 2013). |
| 1017 | U.S. Patent Application Publication No. 2012/0140243 to Colonna de Lega (“Colonna de Lega”) (filed December 1, 2011, published June 7, 2012). |
| 1018 | Karatas et al., “Three-dimensional imaging techniques: A literature review,” <i>European Journal of Dentistry</i> , Vol. 8, Issue 1, 2014; pp. 132-140. |
| 1019 | Broadbent, B.H., “A New X-Ray Technique and Its Application to Orthodontia,” <i>The Angle Orthodontist</i> , Vol. 1, No. 2, 1931; pp. 45-66. |
| 1020 | Hajeer <i>et al.</i> , Current Products and Practices Applications of 3D imaging in orthodontics: Part II, <i>Journal of Orthodontics</i> , vol. 31 (2004). |
| 1021 | Yamany et al., “Free-Form Surface Registration Using Surface Signatures,” <i>The Proceedings of the Seventh IEEE International Conference on Computer Vision</i> , September 20-27, 1999; 7 pages. |
| 1022 | Ireland et al., “3D surface imaging in dentistry – what we are looking at,” <i>British Dental Journal</i> , Vol. 205, No. 7, October 11, 2008; pp. 387-392. |
| 1023 | Remondino et al., “Image-Based 3D Modelling: A Review,” <i>The Photogrammetric Record</i> , Vol. 21, No. 115, September 2006; pp. 269-291. |
| 1024 | Ting-Shu et al., “Intraoral Digital Impression Technique: A Review,” <i>J. Prosthodontics</i> , Vol. 24, No. 4, pp. 313-321. |
| 1025 | Zimmerman et al., “Intraoral scanning systems – a current overview,” <i>Int. J. Comput. Dent.</i> , Vol. 18, No. 2, 2015, pp. 101-129. |

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| Exhibit | Description |
|----------------|---|
| 1026 | Imburgia et al., “Accuracy of four intraoral scanners in oral implantology: a comparative in vitro study,” BMC Oral Health, Vol. 17, No. 1, 2017, p. 92. |
| 1027 | Park et al., “Changes in views on digital intraoral scanners among dental hygienists after training in digital impression taking,” BMC Oral Health, Vol. 15, No. 1, 2015, p.151 (“Park Article”). |
| 1028 | Logozzo et al., “Recent advances in dental optics – Part I: 3D intraoral scanners for restorative dentistry,” Optics and Lasers in Engineering, Vol. 54, 2014, pp. 203-221. |
| 1029 | U.S. Patent Prov. App. No. 61/764,178 to Esbech et al. (“the Provisional Application”) |

I. Introduction

The '244 Patent (U.S. Patent No. 9,962,244; Ex.1001) admits three-dimensional scanners, such as three-dimensional intraocular dental scanners, were well-known in the art. The '244 Patent even identifies foreign and domestic prior art references pertinent to the alleged invention (e.g., U.S. Patent No. 7,698,068 and J.P. Patent App. Pub. No. 2004/029373). Rather, the '244 Patent alleges its protecting -- for the first time -- recording geometry *and* color data of an object as 2D images and creating a three-dimensional image of the object based on the data. But the prior art and expert declaration shows this allegation was incorrect.

In the end, the Examiner (and 3Shape) agreed color and geometry detection was an unpatentable concept, thus forcing 3Shape to add allowed dependent claims to gain issuance of the '244 patent. Yet, as shown by the prior art and declaration, even the allowed dependent claim features, directed to weighted averages, saturated pixels, color filter arrays, and averaged sub-scan colors, were in the prior art. And the dependent claim features were actually allowed only because there was not adequate prior art searching and curtailed examination. If the Examiner had more time, prior art would have been discovered for all the allowed claim features.

Petitioner requests the Board institute post-grant review (PGR) of claims 1-5, 7-10, 12, 15, 16, 18, 21-22, 24, 26, 28, and 29 ("the challenged claims") of the

'244 Patent in view of the Grounds herein, and issue a final written decision finding all challenged claims unpatentable.

II. Identification of challenge (37 C.F.R. § 42. 204(b))

A. Identification of challenge and statement of relief requested

Petitioner respectfully submits two post-grant reviews and requests cancellation of the challenged claims based on 20 grounds as follows:

Petition 1 (the current petition):

| Ground | References | Basis | Claims Challenged |
|---------------|---|--------------|--|
| 1 | Fisker ¹ and Szeliski ² | § 103 | 1-5, 7-10, 15, 16, 18, 21-22, 24, 26, and 28 |
| 2 | Fisker and Matsumoto ³ | § 103 | 1-5, 7-10, 15, 16, 18, 21-22, 24, 26, and 28 |
| 3 | Fisker and Yamada ⁴ | § 103 | 29 |

¹ U.S. Pub. No. 2012/0092461 to Fisker *et al.* (“Fisker”), §102(a)(1), (effectively filed June 17, 2009 and published April 19, 2012). The effective filing date of the ’244 Patent is February 14, 2015. (Section VI.)

² U.S. Pat. No. 6,097,854 to Szeliski *et al.* (“Szeliski”), §102(a)(1) (issued August 1, 2000).

³ U.S. Pat. No. 7,106,348 to Matsumoto *et al.* (“Matsumoto”), §102(a)(1) (issued September 12, 2006).

⁴ U.S. Pub. No. 2007/0035641 to Yamada *et al.* (“Yamada”), §102(a)(1) (published February 15, 2007).

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

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|----|--|-------|---------------------------------------|
| 4 | Fisker and Suzuki ⁵ | § 103 | 29 |
| 5 | Fisker, Szeliski, and Yamada | § 103 | 12 |
| 6 | Fisker, Szeliski, and Suzuki | § 103 | 12 |
| 7 | Fisker, Matsumoto, and Yamada | § 103 | 12 |
| 8 | Fisker, Matsumoto, and Suzuki | § 103 | 12 |
| 9 | Thiel425 ⁶ , Thiel576 ⁷ , and Szeliski | § 103 | 1, 22, and 24 |
| 10 | Thiel425, Thiel576, and Matsumoto | § 103 | 1, 22, and 24 |
| 11 | Thiel425, Thiel576, Szeliski, and Fisker | § 103 | 2-5, 7-10, 15, 16, 18, 21, 26, and 28 |
| 12 | Thiel425, Thiel576, Matsumoto, and Fisker | § 103 | 2-5, 7-10, 15, 16, 18, 21, 26, and 28 |
| 13 | Thiel425, Thiel576, and Yamada | § 103 | 29 |
| 14 | Thiel425, Thiel576, and Suzuki | § 103 | 29 |

⁵ U.S. Pub. No. 2013/0070128 to Suzuki *et al.* (“Suzuki”), §102(a)(2) (effectively filed September 10, 2012).

⁶ U.S. Pub. No. 2010/0067789 to Thiel (“Thiel425”), § 102(a)(1) (published March 29, 2012).

⁷ U.S. Pub. No. 2011/0080576 to Thiel (“Thiel576”), §102(a)(1) (published April 7, 2011).

Petition 2 (the co-pending petition):

| Ground | References | Basis | Claims Challenged |
|---------------|--|--------------|--------------------------|
| 1 | Fisker and Tanaka | § 103 | 31-32 |
| 2 | Fisker and Suzuki | § 103 | 34 |
| 3 | Fisker and Cai | § 103 | 34 |
| 4 | Thiel425, Thiel576, and Tanaka | § 103 | 31-32 |
| 5 | Thiel425, Thiel576, Fisker, and Suzuki | § 103 | 34 |
| 6 | Thiel425, Thiel576, Fisker, and Cai | § 103 | 34 |

There are meaningful distinctions between the two petitions. Even though there is overlapping prior art between the petitions, the petitions challenge the patentability of different claims. Therefore, both petitions should be instituted.

B. The Board should institute all of Petitioner’s proceedings filed against the ’244 Patent to not unjustly prevent Petitioner from challenging the ’244 Patent.

Following the filing of the post-grant reviews, Petitioner will be filing two *inter partes* reviews against the ’244 Patent.

Accordingly, if the Board agrees with the prior art Grounds, Petitioner requests institution and consolidation of the four related post-grant review and *inter partes* review petitions filed against the ’244 patent. Granting institution for all four petitions will allow for the most efficient use of judicial resources without unjustly depriving petitioner of the ability to challenge the ’244 patent for at least two reasons. First, if the Board cannot determine until the final written decision

whether the '244 patent claims are PGR eligible, but has already denied institution for the IPRs, Petitioner will unjustly be forbidden from challenging the '244 patent at the PTAB. Second, the two PGR petitions include nearly identical arguments as compared to the two IPR petitions.

Petitioner believes that the provisional application has no written description support for at least claims 19, 25, and 32. Thus, the earliest effective priority date for at least these claims is post-March 2013, requiring Petitioner to file a PGR. However, Petitioner cannot foresee all evidence 3Shape may be able to provide during trial that might dissuade the Board from holding the '244 patent is PGR eligible. So until the Board can make a final determination regarding PGR eligibility, both the PGRs and IPRs should remain active.

With regards to judicial efficiency, Petitioner has purposely filed nearly identical prior art Grounds against the claims in the PGRs and IPRs knowing that one of the two types of proceedings must fail under the law. In this way, as there are identical issues except which proceeding type is proper, neither the Board nor the 3Shape is prejudiced by instituting and consolidating the proceedings. And this avoids petitioner from being unjustly deprived of challenging the '244 patent at the PTAB. Thus, Petitioner respectfully requests that both PGRs and IPRs filed against the '244 Patent be instituted.

III. The Board should institute trial notwithstanding 35 U.S.C. § 325(d) because all of the factors considered in the § 325(d) analysis weigh in favor of institution.

Section 325(d) provides the Director discretion to deny a petition for PGR if “the same or substantially the same prior art or arguments previously were presented to the Office.” Here, however, all of the factors the Board considers in applying § 325(d) point in favor of institution. Indeed, the Board has previously instituted trial notwithstanding § 325(d) on nearly identical facts to those presented here.

During prosecution, the Examiner rejected independent claims 1, 33, 35, 36, and 38 as obvious over Fisker, but he allowed dependent claims 12, 14, 15, 20, and 22 based on his finding that neither Fisker nor the other prior art before him taught the additional limitations of those claims. The patentee then incorporated the limitations from the dependent claims into the independent claims in order to obtain allowance. Yet, the Examiner performed only two prior-art searches: one in July 2017 (before the only issued Office Action) and one in December 2017 (before the Notice of Allowance). (Ex.1002, 882-888, 924-925.) And the Examiner limited his search for the limitations of the dependent claims to a search within three references identified in IDSs for terms closely resembling some claimed terms – for example, the terms “weight\$3” and “average\$3.” (*Id.*). Had the Examiner had time to expand the initial search and/or the follow-up search, he

likely would have uncovered a litany of references teaching the allowed limitations. Moreover, the Examiner did not consider any additional references in combination with Fisker to teach the limitations of the allowed dependent claims, and he did not provide any substantive rationale for allowance in the Notice of Allowance.

Here, Petitioner's obviousness argument relies on Fisker for the features that the Examiner found obvious over Fisker in the first Office Action, and on new references not considered by the Examiner for the dependent-claim limitations that the Examiner allowed.

In determining whether to deny institution under § 325(d), the Board takes into account the following factors:

- 1) the similarities and material differences between the asserted art and the prior art involved during examination;
- 2) the cumulative nature of the asserted art and the prior art evaluated during examination;
- 3) the extent to which the asserted art was evaluated during examination,
- 4) the extent of the overlap between the arguments made during examination and the manner in which a petitioner relies on the prior art or a patent owner distinguishes the prior art;

- 5) whether a petitioner has pointed out sufficiently how the Office erred in evaluating the asserted prior art; and
- 6) the extent to which additional evidence and facts presented in the petition warrant reconsideration of the prior art or arguments.

Updated Trial Practice Guide at 12. Here, all factors weigh in favor of institution.

With regard to the first three factors, Petitioner is relying on new art not considered by the Examiner to show the obviousness of the limitations allowed by the Examiner, and the art asserted in this PGR is not cumulative of the art evaluated by the Examiner (with the exception of Fisker, which, again, is being used to show the obviousness of the same limitations that the Examiner rejected as obvious over Fisker). The first three § 325(d) factors thus weigh in favor of institution. *Luxshare Precision Industry Co., Ltd. v. Bing Xu Precision Co., Ltd.*, Case IPR2017-01657 (PTAB Jan. 12, 2018) (Paper 17) at 8-9; *Bestway (USA), Inc. v. Intex Marketing Ltd*, Case PGR2017-00003 (PTAB May 11, 2017) (Paper 9) at 7.

The fourth, fifth, and sixth factors—upon which the Board generally places significant weight—strongly indicate in favor of institution as well. Petitioner’s argument is that the Examiner correctly found the rejected claims obvious over Fisker and that other references that were *not* considered by the Examiner render the allowed dependent-claim limitations obvious as well. Thus, Petitioner is not

asking the Board to address arguments that were already considered and rejected by the Examiner.

The *Bestway* and *Luxshare* decisions are on all fours with this case and show why institution is appropriate here. In both of those cases, just as it is here, the petitioners relied on a primary reference that was considered during prosecution, along with secondary references that were not considered by the Examiner. And in both of these cases, the Board rejected the patent owner's argument that it should deny institution under § 325(d), noting that the Examiners had allowed the application without rejecting certain claim features that were challenged using new prior art, and that there was insufficient evidence on record that the Examiner considered the secondary references with respect to the dependent claims' allowable subject matter. *Bestway*, Paper 9 at 7; *Luxshare*, Paper 17 at 8-10.

The Board's decision in *Trans Ova Genetics, LC. v. XY, LLC.*, Case IPR2018-00250 (PTAB June 27, 2018) (Paper 9), is also instructive. There, the Petitioner relied on two references cited and extensively considered during prosecution (Factors 1-3). *Trans Ova Genetics*, Paper 9 at 18-19. Yet, the Board noted that the Petitioner provided substantial evidence indicating the Examiner failed to appreciate the full scope of the prior art's disclosure; the Examiner's appreciation of the prior art's disclosure was fundamental to allowance, and the Petitioner's argument was significantly different than the Examiner's argument

(Factors 4-5). *Id.* Thus, on the basis of Factors 4-5 outweighing Factors 1-3, the Board instituted trial and declined to dismiss on the basis of § 325(d), even when faced with prior art the Examiner thoroughly considered during prosecution. *Id.* The case for institution in the case at hand is even stronger than in *Trans Ova* because Factors 1-3 weigh in favor of institution as well.

* * *

In sum, the Examiner allowed the claims in the application after only searching within three references identified on Applicant-submitted IDSs for terms included in allowed/allowable limitations. The Examiner did not perform any additional searches beyond the Applicant-submitted IDSs or with text outside of the allowed/allowable limitations' claimed terminology. Additionally, the newly cited prior art is only provided to teach the limitations that the Examiner failed to reject. There is thus no overlap between the examination arguments and the instant Petition. There is thus no compelling reason why Section 325(d) would prevent institution on the ground of unpatentability presented in the Petition here.

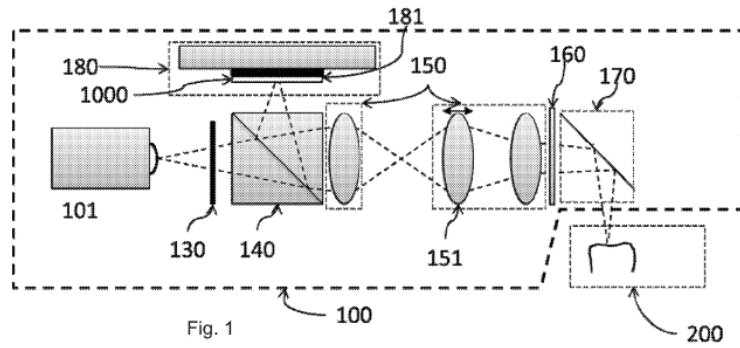
IV. The '244 Patent

A. Overview of the '244 Patent

The '244 Patent relates to “three dimensional (3D) scanning of the surface geometry and surface color of objects,” particularly within dentistry and for intraocular scanning (Ex.1001, 1:6-9.) The '244 Patent provides a scanner system

and a method for recording surface geometry and surface color of an object in order to generate a digital 3D representation of the object expressing both color and geometry of the object. (*Id.*, 2:5-13.)

The '244 Patent provides a scanner system 100 comprising a multichromatic light source 101 that emits light through an optical system 150, which provides 2D images having a pattern onto an object 200 and comprises an adjustable focusing element 150 for shifting the focal imaging plane of the pattern on the object 200. (*Id.*, 15:63-16:18.) The scanner system 100 also comprises a data processing system for deriving geometry information and color information for a block of pixels recorded by a color image sensor 180. (*Id.*, 16:52-60.)



| | | | | | |
|----|----|----|----|----|----|
| 0 | -1 | 0 | 1 | 0 | 1 |
| -1 | 0 | -1 | 0 | 1 | 0 |
| 0 | -1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | -1 | 0 |
| 0 | 1 | 0 | -1 | 0 | -1 |
| 1 | 0 | 1 | 0 | -1 | 0 |

Fig. 3B

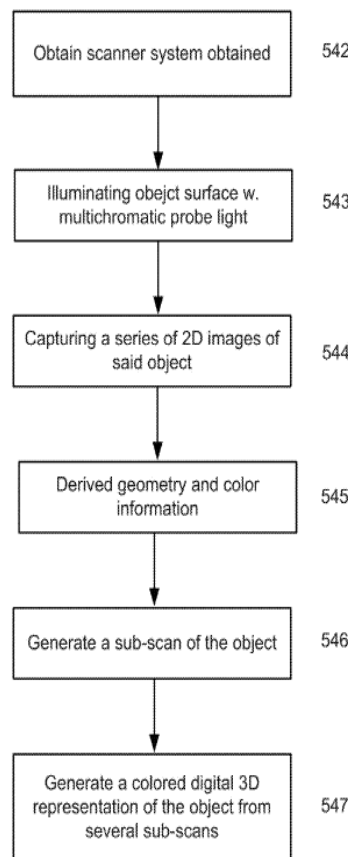
| | | | | | |
|---|---|---|---|---|---|
| G | G | G | G | G | G |
| G | R | G | G | R | G |
| G | G | G | G | G | G |
| G | G | G | G | G | G |
| G | B | G | G | B | G |
| G | G | G | G | G | G |

Fig. 4

(Ex.1001, Figs. 1, 3B, 4.)

The '244 Patent uses a color filter array comprising a plurality of 6x6 color image filters comprised red, blue, and green filters, which are each assigned a weight value (i.e., -1, 0, or 1) in an attempt to obtain natural-color data. (Ex.1001, 17:18-60, Figs. 3B and 4.) The green filters are provided a non-zero value, and the red and blue filters are provided a zero value. (*Id.*, 17:25-26.) Blue color filters in

positions (2,2) and (5,5) of each cell, red color filters in positions (2,5) and (5,2), and green color filters in all remaining positions of the cell. (*Id.*, 17:48-52.) The green filters are only used to obtain the surface geometry information of the object. (*Id.*) As such, the color filter array can be arranged such that its proportion of pixels with color filters that match the selected wavelength range of the spectrum is larger than 50%. (*Id.*, 10:4-7.)



(Ex.1001, Fig. 5.)

The '244 Patent provides a method for recording surface geometry and color of an object. (Ex.1001, 17:61-62, Fig. 5.) First, a scanner system records a series of

2D images of an object from at least two different focus plane positions and derives geometry and color information for a block of image sensor pixels from a plurality of 2D images. (*Id.*, 18:4-15, 18:65-67.) The scanner system thereafter derives geometry and color information at least partly from one of the 2D images. (*Id.*, 18:8-10.) This can comprise (i) calculating for several 2D images a correlation measure between a portion of a 2D image and a weight function based on information of a spatial function and (ii) identifying the position along the optical axis at which the corresponding correlation measure has a maximum value. (*Id.*, 6:29-32.)

The scanner system can then detect saturated pixels in the 2D images and mitigate or remove error in the color information of the 2D images caused by the pixel saturation. (*Id.*, 8:63-67.) Subsequently, the scanner system combines the geometry and color information to generate a sub-scan expressing both geometry and color of a portion of the object. (*Id.*, 18:4-15, 18:65-67.)

The scanner system can thus derive several sub-scans of different portions of an object and combine them to form a 3D representation expressing both geometry and color of an object. (*Id.*, 10:45-53.) Combining the sub-scans can comprise computing a weighted average of color values derived for corresponding points in overlapping sub-scans. (*Id.*, 11:15-19.) The scanner system can also determine a

color of a point on the sub-scan by computing an average of sub-scan colors of surrounding points on the sub-scan. (*Id.*, 7:8-13.)

B. Prosecution History

The Examiner's first and only Office action on the merits only rejected claims in view of prior art references listed on an Information Disclosure Statement submitted by 3Shape with the filing of the application. (Ex.1002, 868-876, 881.) The Examiner indicated a number of dependent claims as containing allowable subject matter. (Ex.1002,875.) Predictably, the Examiner's search and strategy results contained few, if any, terms indicative of the allowable subject matter. (Ex.1002, 882-888.)

In response, the patentee presented five independent claims reciting the subject matter of the base claim, inventing claims (where applicable), and the allowable dependent claim. (Ex.1002, 890-904.) The patentee did not provide any substantive arguments to the prior art on record. (Ex.1002, 905-907.)

The Notice of Allowance ("NOA") was thereafter issued and provided no substantive reasons for allowance. (Ex.1002, 916-923.) Yet again, the Examiner's search and strategy results issued with the NOA contained few, if any, terms indicative of the allowable subject matter. (Ex.1002, 924-925.)

V. POSITA

A person having ordinary skill in the art (“POSITA”) at the time of the invention would have a bachelor’s degree in computer engineering, computer science, electrical engineering, physics, computer vision, or an equivalent field as well as at least one or two years of industry experience, or at least five years of comparable industry experience. (Ex.1003, ¶22.) In particular, a POSITA would have had experience with and knowledge of three-dimensional imaging systems and three-dimensional modeling techniques. (Ex.1003, ¶22.)

VI. Claims 19, 25, and 32 lack support in the Provisional Application requiring PGR eligibility.

AIA Section 6(d) states FITF provisions apply, and thus an application is PGR eligible, when an application contains/contained a claim with an effective filing date prior to March 16, 2013. The Board requires a persuasive showing (e.g., more than “certification”) to illustrate that at least one claim at any time was subject to FITF provisions. *Inguran LLC v. Premium Genetics (UK) Ltd.*, Case PGR2015-00017 (PTAB Dec. 22, 2015) (Paper 8, 9-18) (“PGR ’017). Here, the ’244 patent is PGR eligible because at least claims 19, 25, and 32 lack § 112 support in the priority Provisional application.

A. Claims 19 and 32

Claims 19 and 32, recite in-part, “where the color filters in positions (2,2) and (5,5) of each cell are of the W1 type, the color filters in positions (2,5) and

(5,2) are of the W3 type.” These claim elements are not supported by the Provisional. (Ex.1029; Ex.1003, ¶66.)

The Provisional describes two color filter arrays that may be used—a Bayer pattern and “an alternative color filter array”. (Provisional, 20.) Specifically, the Provisional illustrates, in Figure 4, “an alternative color filter array with a higher fraction of green pixels than in the Bayer pattern” that will “potentially provide a better quality of the obtained 3D surface geometry than a Bayer pattern filter.” (*Id.*, 20-21.) The Provisional notably fails to recite the specific positions of the color filter array pattern. (Ex.1003, ¶67.) A POSITA is merely left with the illustration of Figure 4 to determine the “alternative color filter array” pattern.

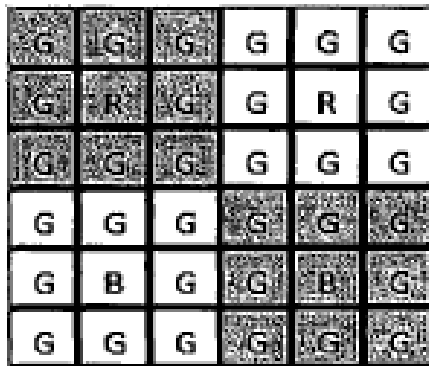


Fig. 4

(Ex.1029, Fig. 4.)

As illustrated, the Provisional Application’s illustrated “alternative color filter array pattern does not disclose where the color filters in positions (2,2) and

(5,5) of each cell are of the W1 type, the color filters in positions (2,5) and (5,2) are of the W3 type. (Ex.1003, ¶68.) No matter which corner of the array is used as the origin, the x,y locations of (2,2) and (5,5) always comprises filters displaying different wavelengths--one is “R” for red, the other is “B” for blue. (Ex.1003, ¶68.) Similarly, the x,y locations of (2,5) and (5,2) always display different wavelengths. (Ex.1003, ¶68.)

Furthermore, to the Provisional fails to provide a color filter array where the color filters in positions (2,2) and (5,5) of each cell are of the W1 type, the color filters in positions (2,5) and (5,2) are of the W3 type. (Ex.1003, ¶69.)

Based on the lack of a written description for this claim element in the Provisional, a POSITA would not have understood that the inventors were in possession of the subject matter of claims 19 and 32. (Ex.1003, ¶70.) Thus, the Provisional Application lacks written description for this claim. (Ex.1003, ¶70.)

B. Claim 25

Claim 25 recites, “where the color filter array is such that the proportion of the image sensor pixels of the color image sensor with color filters that match the selected wavelength range of the spectrum has a proportion that equals 32/36, 60/64 or 96/100.” This claim element is not supported by the Provisional. (Ex.1003, ¶71.)

The Provisional fails to recite the specific positions of the color filter array pattern. (Ex.1003, ¶72.) And, notably, the Provisional fails to recite any specific proportions of the image sensor pixel color filters. (Ex.1003, ¶72.) That is, the Provisional merely states that “the color filter array is such that its proportion of pixels with color filters that match the first part of the spectrum is larger than 50%.” (Ex.1029, 16.) A POSITA, again, is merely left with the illustration of Figure 4 to determine the specific proportions of the image sensor pixel color filters. (Ex.1003, ¶72.)

| | | | | | |
|---|---|---|---|---|---|
| G | G | G | G | G | G |
| G | R | G | G | R | G |
| G | G | G | G | G | G |
| G | G | G | G | G | G |
| G | B | G | G | B | G |
| G | G | G | G | G | G |

Fig. 4

(Ex.1029, Fig. 4.)

As illustrated, the proportion of “G” color filters against the number of R and B filters is 32/36. (Ex.1003, ¶73.) But, the Provisional is entirely silent with respect to an array having 64 or 100 pixels (or factors thereof), much less the proportion/number of green, red, and blue pixels. (Ex.1003, ¶73.)

Based on the lack of a written description for this claim element in the Provisional Application, a POSITA would not have understood that the inventors were in possession of the subject matter of claim 25. (Ex.1003, ¶74.) Thus, the Provisional Application lacks written description for this claim. (Ex.1003, ¶74.)

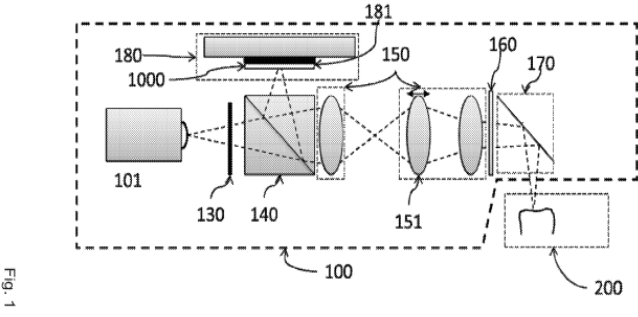
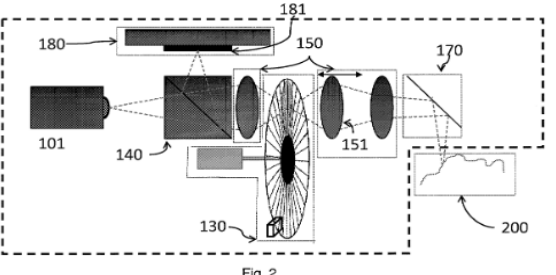
VII. Grounds 1 and 2: The combinations of Fisker and Szeliski (Ground 1) and Fisker and Matsumoto (Ground 2) render claims 1-5, 7-10, 15, 16, 18, 21, 22, 24, 26, and 28 obvious.

A. Claim 1

1. [1.P]: “A focus scanner for recording surface geometry and surface color of an object”

Fisker discloses a focus scanning apparatus. (Ex.1005, Title.) For example, Fisker teaches “a handheld scanner for obtaining and/or measuring the 3D geometry of at least a part of the surface of an object using confocal pattern projection techniques.” (*Id.*, Abstract.) Fisker additionally teaches that its scanner is “adapted to obtain the color of the surface being scanned.” (*Id.*, [0151].)

The similarity of the focus scanner systems of the '244 Patent and Fisker are illustrated below:

| | |
|---|---|
| <p>'244 Patent: "FIG. 1 shows a handheld embodiment of a scanner system." (Ex.1001, 15:53-55.)</p> | <p>Fisker: "FIG. 2: A schematic presentation of a second example embodiment of the device according to the invention (optical correlation)." (Ex.1005, [0221].)</p> |
|  <p style="text-align: center;">(Ex.1001, Fig. 1.)</p> |  <p style="text-align: center;">(Ex.1005, Fig. 2.)</p> |

Thus, Fisker teaches the preamble of this claim. (Ex.1003, ¶89.)

2. [1.1]: "a multichromatic light source configured for providing a multichromatic probe light for illumination of the object"

Fisker teaches a scanner head that comprises "a light source 110." The light "from the light source 110 travels back and forth through the optical system 150." (Ex.1005, [0244].) As the light travels back and forth, the scanner sees the variation in the light signal corresponding to the variation of the light illuminating the object. (Ex.1005, [0086], [0110].) Fisker further discloses that "[t]o obtain color information the light source needs to be white or to comprise at least three monochromatic light sources with colors distributed across the visible part of the electromagnetic spectrum." (Ex.1005, [0151].) The '244 Patent provides a white

light source as an example of a multichromatic light. (Ex.1001, 5:23-25.) Thus, Fisker teaches this limitation. (Ex.1003, ¶91.)

3. [1.2]: “a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from said object”

To provide color information (Section VII.A.2), Fisker teaches a color image sensor comprising an “array of sensor elements” or “sensor elements (pixels).” (Ex.1005, [0070], [0152].) And in Fisker’s description of its digital camera, Fisker refers to sensor elements as pixels. Therefore, Fisker’s array of sensor elements (pixels) teaches the recited “array of image sensor pixels.” (Ex.1005, [0070]; Ex.1003, ¶¶92-94.) Finally, in Fisker one or more 2D images are captured at the color image sensor when light is transmitted through a pattern towards the object and by imaging “light reflected from the object to the camera.” (*Id.*, [0028], [0061]; Ex.1003, ¶92.)

Thus, Fisker teaches this limitation. (Ex.1003, ¶94.)

4. [1.3.a]: “wherein the focus scanner is configured to operate by translating a focus plane along an optical axis of the focus scanner”

Fisker describes an optical axis as a “straight line” defined by the “configuration of a plurality of optical components, e.g., the configuration of lenses in the optical system.” (Ex.1005, [0041].) Fisker’s optical system includes a “focus element” that includes a “translation stage for adjusting and controlling the

position of the focus element.” (*Id.*, [0064].) That is, Fisker’s focus plane “may be varied, for example by translating the focus element back and forth along the optical axis.” (*Id.*) Thus, Fisker teaches this limitation. (Ex.1003, ¶96.)

5. [1.3.b]: “wherein the focus scanner is configured to operate by...capturing a series of the 2D images, each 2D image of the series is at a different focus plane position such that the series of captured 2D images forms a stack of 2D images”

Fisker teaches a process for “recording a series of images” of a pattern being projected onto a surface, where the completed series of images becomes a stack of images. (Ex.1005, [0260]; Ex.1003, ¶¶97-98.) Each of the images is “taken at different positions of the focusing element, in effect covering the entire travel range of said focus element.” (*Id.*) Fisker further teaches that as the “time varying pattern” is projected onto the surface being scanned, “a number of 2D images” are collected at the “different positions of the focus plane and at different instances of the pattern.” (*Id.*, [0028].) Fisker’s different positions of the focus plane teach the recited “different focus plan positions” as recited in part in this limitation.

(Ex.1003, ¶97.)

Moreover, Fisker’s series of 2D images captured over the full range of the focus element when combined forms (teaches) a “stack of 2D images” as recited in in this limitation. (Ex.1003, ¶¶97-98) Thus, Fisker teaches this limitation.

(Ex.1003, ¶98.)

6. [1.4.a]: “a data processing system configured to derive surface geometry information for a block of said image sensor pixels from the 2D images in the stack of 2D images captured by said color image sensor”

The '244 Patent does not provide an explicit definition for a “block” of sensor pixels. (Ex.1003, ¶99.) The '244 Patent does, however, appear to use the terms “block” of sensor pixels and “group” of sensor pixels, interchangeably. (*e.g.*, Ex.1001, 18:24-26 (“The correlation measure is determined for all active *image sensor pixel groups* [emphasis added] on the color image sensor for every focus plane position, i.e., for every 2D image of the stack”); 5:50-54 (“deriving the surface geometry information and the surface color information for *a block of image sensor pixels* [emphasis added] comprises identifying the position along the optical axis at which *the corresponding correlation measure* [emphasis added] has a maximum value.”).) Accordingly, it appears that the terms “block” or “group” of sensor pixels may include all sensor pixels in the array of pixels or a subset thereof. (*Id.*; Ex.1003, ¶99)

Fisker teaches capturing a series/stack of 2D images. (Section VII.A.5; Ex.1003, ¶100) and a “data processing system.” (Ex.1005, [0074], [0192].) Fisker includes an embodiment that is “adapted to obtain the color of the surface being scanned, i.e. capable of registering the color of the individual surface elements of the object being scanned together with the surface topology of the object being

scanned.” (*Id.*, [0151].) That is, Fisker’s obtaining the surface topology of the object being scanned teaches “deriv[ing] surface geometry information” as recited in part in this limitation. (Ex.1003, ¶100.)

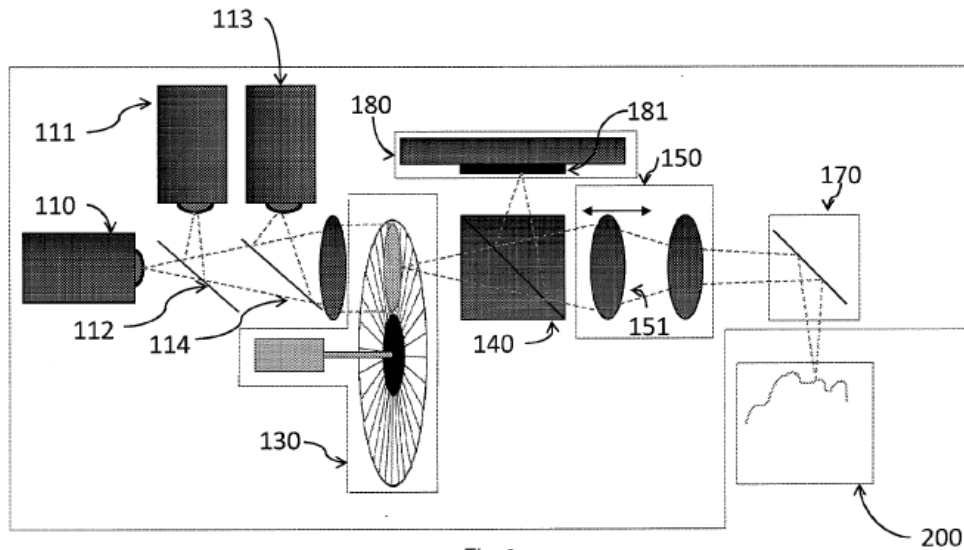
Like the ’244 Patent, Fisker discloses a group of sensor pixels (i.e., a block of image sensor pixels). (Ex.1005, [0070], [0128].) For example, Fisker teaches that the “focus position corresponding to the pattern being in focus on the object for *a single group of sensor elements* [emphasis added] in the camera will be given by an extremum value of the correlation measure of that sensor element group.”(*Id.*, [0128].)

Fisker’s group of pixels teaches the recited “block” of image sensor pixels because Fisker’s sensor pixels perform the same functions and because the ’244 Patent uses the terms block and group interchangeably.(Ex.1003, ¶¶101-102.) Thus, Fisker teaches this limitation. (Ex.1003, ¶103.)

7. **[1.4.b]: “the data processing system also configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information”**

The ’244 Patent discloses a scanner system for recording surface geometry and surface color, in which the surface geometry and color information are “acquired *simultaneously*” using one image sensor. (Ex.1001, 2:1-13.) Similarly,

Fisker teaches, and illustrated in Figure 9, a device for “*simultaneous scanning of a surface shape and color*” using one image sensor 181. (Ex.1005, [0228], [0244].)



(Ex.1005, Fig. 9.)

Fisker’s data processing system is also “adapted to obtain the color of the surface being scanned, i.e. capable of registering the color of the individual surface elements of the object *being scanned together with* [emphasis added] the surface topology of the object being scanned.” (Section VII.A.6; Ex.1005, [0151]; Ex.1003, ¶105.) Fisker’s image sensor “provides color registration at each sensor element,” based on the amplitude of light received at *each of the sensor elements*. (Ex.1005, [0151]-[0157].) The amplitude is determined for each group of pixels (i.e., a block of image pixels) (*id.*, [0030]) for at least one color at every focal plan position. (*Id.*, [0158].) So, at every focus position, the amplitude of light received at the sensor elements is used to determine surface topology and the surface color

for each image sensor element in the sensor. (Ex.1005 , [0151]-[0158], [0279]; Ex.1003, ¶105.)

Fisker teaches a data processing system configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information. (Ex.1003, ¶107.) Thus, Fisker teaches this limitation. (Ex.1003, ¶107.)

8. [1.5.a]: “wherein the data processing system further is configured to combining [sic] a number of sub-scans to generate a digital 3D representation of the object, and”

The '244 Patent describes a sub-scan as expressing “at least the geometry of the part of the object.” (Ex.1001, 3:61-63.)

Fisker discloses a method for combining a number of sub-scans to generate a digital 3D representation. Fisker teaches that different regions of the scanned surface will be in focus in different images. (Ex.1005, [0261].) “In focus regions within an image are found as those of maximum intensity variance (indicating maximum contrast) over the entire said series of images.” (*Id.*, [0262].) Fisker further describes a “fused image” that is generated by “combining all the in-focus regions of the series” of images, “thereby providing a full 3D model.” (*Id.*, [0173], [0263].) Fisker further describes this as a stitching and/or registering process where “partial scans” are combined. (*Id.*, [0175].) For example, Fisker’s claim 136 recites

“combining at least two partial scans to a 3D model of the surface of an object.”

(*Id.*, [0175] and claim 136; Ex.1003, ¶¶109-111.)

Based at least on the foregoing, Fisker teaches this limitation. (Ex.1003, ¶112.)

9. [1.5.b]: “determining [sic] object color of at least one point of the generated digital 3D representation of the object from sub-scan color of the sub-scans combined to generate the digital 3D representation”

Fisker teaches a “data processing system” that is configured to perform the disclosed methods. (Section VII.A.6; Ex.1005, [0074], [0192].) Fisker is “adapted to *obtain the color* of the surface being scanned, i.e. capable of registering the color of the individual surface elements of the object being scanned together with the surface topology of the object being scanned.” (*Id.*, [0151].) Fisker’s obtaining the color of the surface being scanned and registering the color of the *individual surface elements* teaches determining the object color of *at least one point* of the object. (Ex.1003, ¶113)

Fisker also teaches converting the 2D image data into a 3D surface data and then “merging and/or combining 3D data for the interior and exterior part of the ear provided, thereby providing a full 3D model of a human ear.” (Ex.1005, [0032], [0173].)

Because Fisker collects the surface geometry and the surface color of the scanned surface using data obtained at individual surface elements, it would have been obvious that the full digital 3D representation, and model thereof, would include the object color of a least one point of the generated digital 3D representation of the object from sub-scan color of the sub-scans combined to generate the digital 3D representation. (Ex.1003, ¶115) Thus, Fisker teaches this limitation. (Ex.1003, ¶116)

10. [1.5.c]: “such that the digital 3D representation expresses both geometry and color profile of the object”

Fisker further discloses “merging and/or combining 3D data for the interior and exterior part of the ear provided, thereby providing a full 3D model of a human ear.” (Ex.1005, [0173].) Because Fisker collects the surface geometry and the surface color of the scanned surface, it would have been obvious that the full digital 3D representation would express both the geometry and color profile of the scanned object. (Ex.1003, ¶117) Thus, Fisker teaches this limitation. (Ex.1003, ¶118)

11. [1.6]: “wherein determining the object color comprises computing a weighted average of sub-scan color values derived for corresponding points in overlapping sub-scans at that point of the object surface.”⁸

a) Fisker

Fisker teaches a “fused image” that is generated by “combining all the in-focus regions of the series” of images. (Ex.1005, [0263].) Fisker further teaches that the fused image “can be interpreted as the reference signal and the reference vector/set of weight values...for the [] pixels in the pixel group...” (*Id.*, [0263]-[0264].) Fisker’s color is further “expressed as e.g. an RGB color coordinate of each surface element can be reconstructed by appropriate weighting of the amplitude signal for each color corresponding the maximum amplitude.” (*Id.*, [0279].)

While Fisker describes a weighting scheme for expressing color values for the scanned pixels, to the extent 3Shape argues that Fisker does not teach computing a weighted average, it was known in the prior art, e.g., as taught by Szeliski (Ground 1) and Matsumoto (Ground 2). (Ex.1003, ¶123)

⁸ This claim limitation did not face a rejection during prosecution. This limitation was added to claim 1 to overcome Fisker. But based on the arguments herein, the Examiner should not have found this feature allowable.

b) Szeliski (Ground 1)

Szeliski provides a method for “computing texture map color values for any geometry and choice of texture map coordinates.” (Ex.1006, 28:44-46.) Szeliski further teaches a method for mapping multiple images, using focal length and 3D rotation, to build an image mosaic by “registering a sequence of images by recovering their transformation matrices M_k .” (*Id.*, 7:4-18, 14:24-29.) Each of Szeliski’s transformations correspond to “one image and represents the mapping between the image pixels of I_k and a viewing directions in the world (i.e., a 3D world coordinate system).” (*Id.*)

As illustrated at Szeliski Step 3250 in Figure 32, Szeliski teaches a method for using a weighted average calculation to blend color data from corresponding pixels (i.e., points) in overlapping images. (Ex.1006, Fig. 32; 30:20-49.)

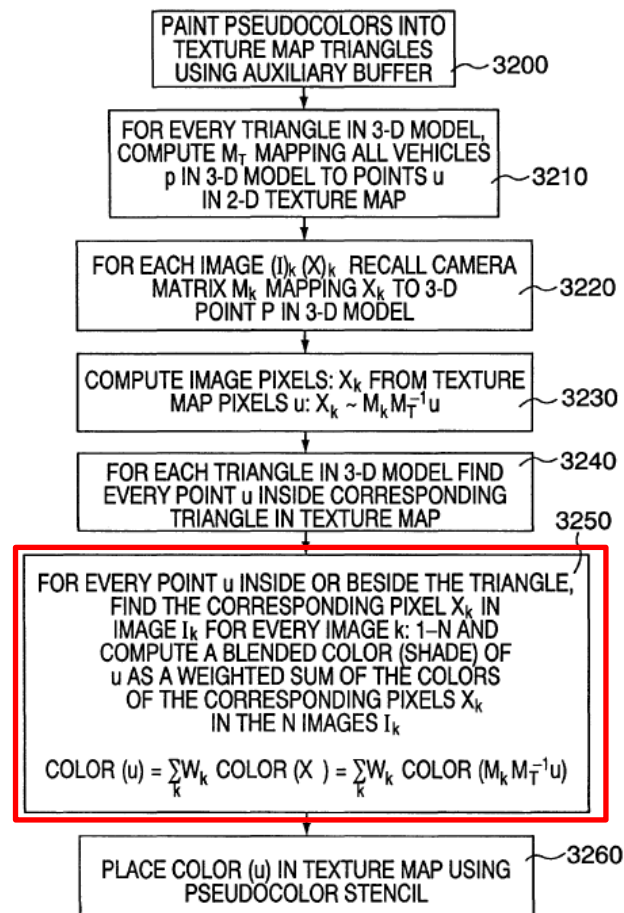


FIG. 32

(Ex.1006, Fig. 32 (annotated).)

More specifically, for every point, “a mapping to *the corresponding pixel* [emphasis added] in every overlapping image is found, and those corresponding pixel values (colors or intensities) are *blended to form a composited pixel value* [emphasis added].” (Ex.1006, 30:20-24.) The composite pixel value is calculated from corresponding pixels in overlapping images using a weighted average according to the following equation:

$$\text{COLOR}(u) = \sum_k W_k \text{COLOR}(X_k) = \sum_k W_k \text{COLOR}(M_k M_T^{-1} u)$$

(*Id.*, Fig. 32.) Szeliski thus teaches blending the “color (shade) of u as a weighted sum of the colors of the corresponding pixels X_k in the n images I_k .” (*Id.*)

Szeliski is analogous art because, like the '244 Patent, it uses a processing means (or a computing system) to analyze and process captured images and for constructing/rendering 3D images—while seeking to improve image quality and alignment (*Id.*, 1:9-12, 7:4-18, 14:24-29; Ex.1003, ¶¶137, 140, 147.)

Therefore, the combination of Fisker and Szeliski teaches this limitation.
(Ex.1003, ¶128)

c) Matsumoto (Ground 2)

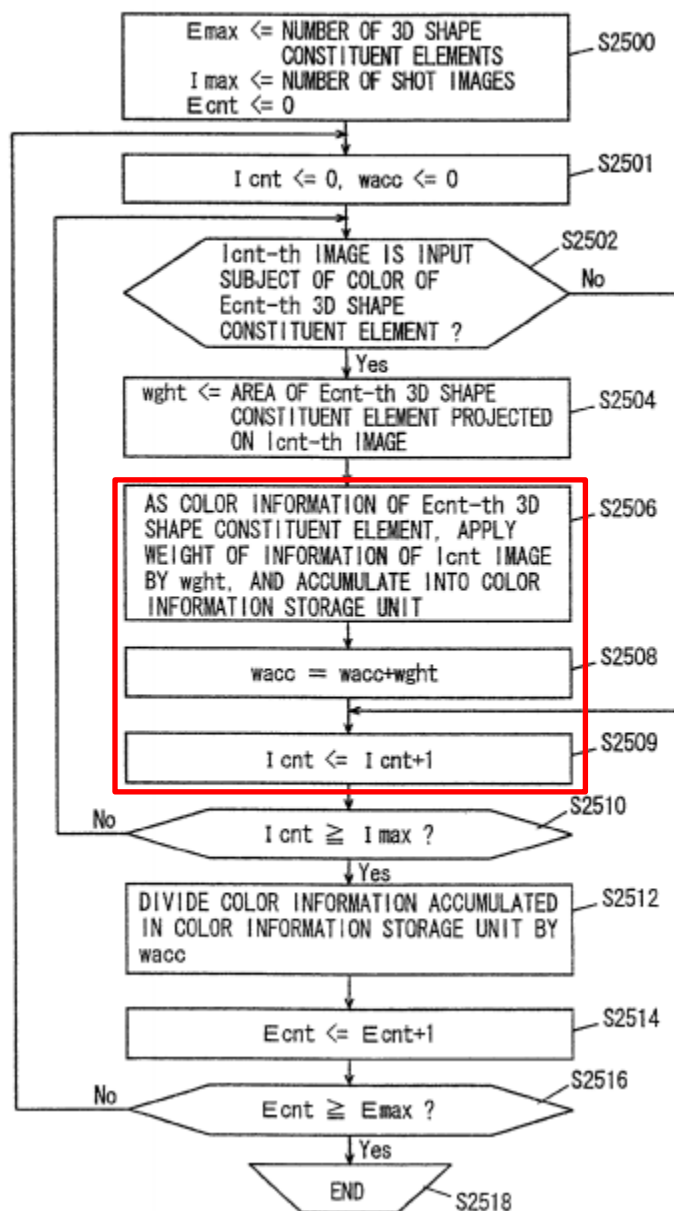
Matsumoto discloses a weighted mean process that is applied to image information (color, density or luminance) and results in improved texture information and a 3D model of higher accuracy. (Ex.1007, 5:30-34, 7:48-50.)

Matsumoto further teaches “capturing a plurality of object images information by shooting an object of interest from different viewpoints” and “assigning texture information obtained by carrying out *a weighted mean process* for all the object image information according to the area corresponding to the three-dimensional shape constituent element.” (*Id.*, 8:32-37.)

As illustrated at step S2509 in Figure 19 below, Matsumoto’s weighted mean process teaches that the “ i -th reference image information subjected to a

weight of variable wght is stored in color information storage unit 240 as the texture information of the Ecnt-th three-dimensional shape constituent element (step S2506).” (*Id.*, 27:36-39.) The values of “variable wght” are then “accumulated for variable wacc (step S2508).” (*Id.*, 27:40-42.) Icnt and Ecnt are auxiliary variables used to count/label images and polygons within the images, respectively. (Ex.1003, ¶132) Accordingly, Matsumoto’s method assigns a weighting variable to corresponding points on corresponding images. (Ex.1003, ¶132)

FIG. 19



(Ex.1007, Fig. 19.)

Matsumoto is analogous art because, like the '244 Patent, it uses a processing means (or computing system) to analyze and process captured images. (Ex.1007, 31:3-31; Ex.1003, ¶¶137, 140, 147.) Matsumoto's image processing

techniques result in improved texture information and a 3D model of higher accuracy. (Ex.1007, 5:30-34, 7:48-50.)

Therefore, the combination of Fisker and Matsumoto teaches this limitation. (Ex.1003, ¶136)

**d) Motivation to Combine: Fisker and Szeliski (Ground 1)
and Fisker and Matsumoto (Ground 2)**

Fisker, Szeliski, and Matsumoto are all analogous art as each use a processing means (or computing system) to analyze and process captured images, as does the challenged '244 Patent. (Ex.1003, ¶137.) Each is directed to a computer system for constructing and rendering 3D images. (Ex.1005, [0001]; Ex.1006, 1:9-12; Ex.1007, Abstract.) And each is similarly concerned with image quality and alignment (Ex.1003, ¶137.)

For example, Szeliski teaches a mosaic or “stitching” method for aligning and compositing overlapping images into a model. For example, “for every point in a given triangle of the 3D model, thus defining the pixels in the corresponding triangle in texture space.” (Ex.1006, 30:17-20.) In Szeliski’s step 3250, “for every point in a bounding box surrounding a given triangle in texture space, a mapping to the corresponding pixel in every overlapping image is found, and those corresponding pixel values (colors or intensities) are blended to form a composited pixel value” based on a weighted average. (*Id.*, 30:17-30.)

Image mosaic methods, like the methods taught by Szeliski, were commonly used in the dental industry to create 3D models. For example, in “Digital Dental Revolution,” a textbook that provides an overview of intraoral scanners and image processing methods where overlapping scans are stitched together to produce a 3D virtual model. (Ex.1014, 102-103, Figs. 32, 33.)

Similarly, Matsumoto teaches a weighted mean process that is applied to image information (color, density, or luminance) and results in improved texture/color information and a 3D model of higher accuracy. (Ex.1007, 5:30-34, 7:48-50.) More specifically, Matsumoto teaches a weighted mean process for images captured from differing viewpoints and using the collected image data to create a 3D model. (*Id.*, 8:31-37.)

A POSITA would have been motivated to make the minor modification required to Fisker’s image processing method to include Szeliski’s and Matsumoto’s similar processing method. (Ex.1003, ¶140.) The resulting combination is little more than the use of a known image processor and known image processing technique to improve image quality—e.g., produce a more accurate and clear image using data captured by multiple images. (Ex.1003, ¶140.) A POSITA thus would have improved image processing systems and methods, like Fisker’s, in the same way that Szeliski suggests—namely, improving image quality by blending color from multiple images to account for movements in the image

(Ex.1006, Figs. 1, 32, 4:1-9,) and in the same way that Matsumoto suggests—applying a weighted mean process by assigning a weight variable to the stored color information and then accumulating the information. (Ex.1007, 4:1-9; Ex.1003, ¶140)

And after the combination, each feature would continue to function as intended. *See KSR Int’l. Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007).

Moreover, a POSITA would have modified and enhanced Fisker’s image processor and known image processing techniques with that of Szeliski and Matsumoto for at least two reasons. (Ex.1003, ¶141.)

First, a POSITA would have recognized the advantages of Szeliski and Matsumoto’s teachings with respect to combining images from multiple focal depths and/or viewpoints to determine the correct pixel texture and color. (Ex.1003, ¶142.) Fisker teaches that its system comprises a “means for varying the position of the focus plane” while images are captured. (Ex.1005, [0010].) Fisker further teaches obtaining “the color of the surface being scanned.” (Ex.1005, [0151].) Fisker teaches: “evaluating a correlation measure at each focus plane position between at least one image pixel and a weight function, where the weight function is determined based on information of the configuration of the spatial pattern” (Ex.1005, [0017].) To be sure, Fisker does not teach using a weight function to derive surface color information, but it does recognize the advantages

of using a weight function to improve image quality. (*Id.*; Ex.1003, ¶142.) Thus, Szeliski's and Matsumoto's methods for computing a blended color as a weighted sum of the colors of corresponding pixels and assigning texture information obtained by carrying out a weighted mean process, respectively, would have been an obvious modification to improve Fisker. (Ex.1003, ¶142.)

Second, a POSITA would have recognized the advantages of Szeliski's method for accounting for scanner movement. (Ex.1003, ¶143.) Fisker provides that its method is related to "[s]pecific embodiments...for intraoral scanning and scanning of the interior part of a human ear." (Ex.1005, Abstract.) However, a POSITA would have understood that Fisker's method requires "varying the position of the focus plane of the pattern on the object while maintaining a fixed spatial relation of the scanner and the object." (Ex.1005, [0015].) A POSITA would have understood that performing an intraoral and/or an interior ear scan, while maintaining a fixed spatial relationship between the scanner and the object being scanned, is extremely difficult. (Ex.1003, ¶143.) Szeliski specifically solves the problem of a moving scanner (or moving object). That is, Szeliski teaches that its system "solves the problem of loss of detail or image ghosting by computing local motion estimates (block-based optical flow) between pairs of overlapping images, and using these estimates to warp each input image so as to reduce the misregistration." (Ex.1006, 4:1-9.) Thus, a POSITA would have recognized the

advantages of applying a method of accounting for motion of either the scanner or the object being scanned. (Ex.1003, ¶143.)

A POSITA would have modified and enhanced Fisker's image processor and known image processing technique with that of Matsumoto to improve the color and texture continuity of the image data by carrying out Matsumoto's weighted mean process. (Ex.1007, 27:36-43; Ex.1003, ¶144.) Specifically, Matsumoto's techniques provide "a method and apparatus of three-dimensional model generation that can generate a three-dimensional model in high accuracy" even when several images, in a plurality of images, are inaccurate. (Ex.1007, 5:30-34.)

The '244 Patent, Fisker, Szeliski, and Matsumoto are concerned with providing clear and accurate images, including surface topography and surface color of the image being scanned. (Ex.1003, ¶145.) And as Dr. Bajaj discusses in his declaration, improving image quality using a weighted average was well known in the prior art. (Ex.1003, ¶145 citing Bernardini, Tanaka, Suzuki, and Park.)

A POSITA would have understood the advantages of enhancing Fisker's image processor with the known image processing techniques of Szeliski or Matsumoto. (Ex.1003, ¶148.) Thus, the benefits of employing a Szeliski-like method or a Matsumoto-like method for processing images in an image processor,

such as that of Fisker, would have been predictable to a POSITA. *KSR*, 550 U.S. at 417. (Ex.1003, ¶148.)

As provided above, Fisker's image processor and method for processing images would have benefited from Szeliski's and Matsumoto's method for combining the data of multiple images into a 3D representation of that data. (Ex.1003, ¶149.) Fisker teaches "a computer program product comprising program code means for causing a data processing system to perform the method, when said program code means are executed on the data processing system." (Ex.1005, [0192].) Similarly, Szeliski explains that its methods are performed by computer systems using "program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks." (Ex.1006, 7:52-60.) Yet further, Matsumoto explains that "the object extraction apparatus includes a computer 130" and that "[c]omputer 130 detects and extracts an object portion in the object image according to a program 301." (Ex.1007, 30:33-35.)

Based on the foregoing, and a POSITA's experience, a POSITA would have understood that the method for processing images, as described in each of the '244 Patent, Fisker, Szeliski, and Matsumoto is conducted based on computer programs/software using a processing means. (Ex.1003, ¶150.) Thus, to achieve the benefits of Szeliski's and Matsumoto's image processing modules, it would have been obvious to enhance Fisker's software (and algorithms) using routine

coding and engineering practices. (Ex.1003, ¶150.) Therefore, a POSITA would have been motivated to enhance Fisker's method for processing images to include a Szeliski-style method for combining image data from multiple scans, accounting for scanner movement, and determining a scanned object's color using data from multiple images and a Matsumoto-style method for improving the color and texture continuity of the image data, resulting in a more accurate 3D model. (Ex.1003, ¶150.)

Finally, a POSITA would have had a reasonable expectation of success when enhancing Fisker's image processing method with that of Szeliski and Matsumoto. (Ex.1003, ¶151.) As Dr. Bajaj explains, such a modification would have been a routine matter for a POSITA. (Ex.1003, ¶151.) For example, Dr. Bajaj states the methods of Szeliski and Matsumoto would not require any additional hardware and could be implemented within Fisker's data processor by adding, or altering, the computer code that controls the image processing algorithms. (Ex.1003, ¶151.)

* * *

For at least the foregoing reasons, a POSITA would have found it obvious to enhance Fisker's image processing methods and systems with the methods of Szeliski or Matsumoto and that the combinations of Fisker and Szeliski (Ground 1) and Fisker and Matsumoto (Ground 2) teach this limitation. (Ex.1003, ¶152.)

- B. Claim 2: “The focus scanner according to claim 1, wherein the data processing system is configured for generating a sub-scan of a part of the object surface based on surface geometry information and surface color information derived from a plurality of blocks of image sensor pixels.”**

In addition to the explanations in Sections VII.A.8-9, Fisker discloses “a method and a scanner for obtaining and/or measuring the 3D geometry of at least *a part of the surface of an object.*” (Ex.1005, [0010].) Fisker’s scanner is further adapted to obtain the color of the surface being scanned together with the surface topology of the object being scanned. (*Id.*, [0151].) Fisker’s processing system is also adapted for recording, integrating, monitoring, and/or storing each of a plurality of the sensor elements over a range of focus plane positions and then combining and/or weighing the collected information. (Ex.1005, [0114], [0157].) Thus, Fisker teaches this claim. (Ex.1003, ¶¶153-154.)

- C. Claim 3: “The focus scanner according to claim 1, where the scanner system comprises a pattern generating element configured for incorporating a spatial pattern in said probe light.”**

Fisker teaches a scanner head comprising a “pattern generation means 130” that when light passes through the optical system, the light “images the pattern 130 onto the object being scanned 200 and further images the object being scanned onto the image sensor 181.” (Ex.1005, Fig. 1, [0244].) Fisker further discloses that its “pattern is varied in time in a periodic fashion for a fixed focus position then the in-focus regions on the object will display an *spatially varying pattern.*” (*Id.*,

[0246].) Furthermore, the spatial pattern is incorporated in the probe light (*Id.*,

[0012].) Thus, Fisker teaches this claim. (Ex.1003, ¶¶155-156)

D. Claim 4: “The focus scanner according to claim 1, where deriving the surface geometry information and surface color information comprises calculating for several 2D images a correlation measure between the portion of the 2D image captured by said block of image sensor pixels and a weight function, where the weight function is determined based on information of the configuration of the spatial pattern.”

Fisker teaches deriving the surface geometry information and surface color information for a block of image sensor pixels. (Section VII.A.6-7.) Fisker further teaches a “means for evaluating a correlation measure at each focus plane position between at least one image pixel and a weight function, where the weight function is determined based on information of the configuration of the spatial pattern.”

(Ex.1005, [0017].) Because Fisker evaluates a correlation measure at “each focus plane,” Fisker teaches calculating a correlation measure for several 2D images.

(Ex.1003, ¶¶157, 160)

Like the '244 Patent, Fisker's correlation measure is a “measure between the weight function and the recorded light signal” that “translates to a pixel value within an image” and is computed using several camera sensors. (Ex.1005, [0053], [0054].) That is, Fisker teaches calculating a correlation measure between the portion of the 2D image captured by said block of image sensor pixels and a weight function. (Ex.1003, ¶¶161)

The similarities between the correlation measures disclosed in the '244 Patent and that of Fisker are further exemplified by the following table:

| '244 Patent | Fisker |
|---|---|
| <p>One way to define the correlation measure mathematically with a discrete set of measurements is as a dot product computed from a signal vector, $I=(I_1 \dots I_n)$, with $n>1$ elements representing sensor signals and a reference vector, $f=(f_1, \dots, f_n)$, of same length as said signal vector of reference weights. The correlation measure A is then given by</p> $A = f \cdot I = \sum_{i=1}^n f_i I_i$ <p>(Ex.1001, 6:1-12.)</p> | <p>One way to define the correlation measure mathematically with a discrete set of measurements is as a dot product computed from a signal vector, $I=(I_1 \dots I_n)$, with $n>1$ elements representing sensor signals and a reference vector, $f=(f_1, \dots, f_n)$, of same length as said signal vector of reference weights. The correlation measure A is then given by</p> $A = f \cdot I = \sum_{i=1}^n f_i I_i$ <p>(Ex.1005, [0076].)</p> |

Furthermore, as Dr. Bajaj explains, the correlation measures of the '244 Patent and of Fisker are calculated using the same equation. (Ex.1003, ¶162) Thus, Fisker teaches this claim. (Ex.1003, ¶163)

- E. Claim 5: “The focus scanner according to claim 4, wherein deriving the surface geometry information and the surface color information for a block of image sensor pixels comprises identifying the position along the optical axis at which the corresponding correlation measure has a maximum value.”**

Fisker teaches deriving the surface geometry information and surface color information for a block of image sensor pixels. (Sections VII.A.6-7 and VII.D.)

Fisker further teaches identifying the position along the optical axis at which the corresponding correlation measure has a maximum value. (Ex.1005, [0288].) For example, Fisker teaches that its focus plan is controlled by focusing optics and that for each pixel, it is possible to “*identify* individual settings of the focusing optics for which each pixel will be in-focus.” (*Id.*)

Fisker further teaches that the “focus position corresponding to the pattern being in focus on the object being scanned for a single sensor element in the camera will then be given by the maximum value of the correlation measure recorded with that sensor element when the focus position is varied over a range of values.” (Ex.1005, [0114].) Because Fisker’s focus position is varied by translating its focus plane along an optical axis (Section VII.A.4-5), obtaining a maximum correlation measure value when the pattern is in focus, teaches this claim.

(Ex.1003, ¶165)

- F. Claim 7: “The focus scanner according to claim 6, where the maximum correlation measure value is the highest calculated correlation measure value for the block of image sensor pixels and/or the highest maximum value of the correlation measure function for the block of image sensor pixels.”**

Fisker teaches calculating for several 2D images a correlation measure between the portion of the 2D image captured by said block of image sensor pixels and a weight function (Section VII.D) and identifying the position along the optical axis at which the correlation measure functions have their maximum value for the block (Section VII.F).

Fisker also discloses the “global maximum” correlation measure value which gives the “focus position corresponding to the pattern being in focus on the object being scanned.” (Ex.1005, [0114].) In other words, Fisker further discloses that its “[i]n-focus regions are found as those of maximum intensity variance (indicating maximum contrast) over the entire said series of images.” (*Id.*, [0262].)

Thus, Fisker teaches this claim. (Ex.1003, ¶169)

- G. Claim 8: “The focus scanner according to claim 5, wherein the data processing system is configured for determining a sub-scan color for a point on a generated sub-scan based on the surface color information of the 2D image in the series in which the correlation measure has its maximum value for the corresponding block of image sensor pixels.”**

Fisker teaches a data processing system configured for deriving the sub-scan color for a point on a generated sub-scan using a correlation measure. (Sections VII.A.7-8 and VII.D-E.) Fisker’s scanner is “adapted to *obtain the color* of the

surface being scanned, i.e. capable of registering the color of the individual surface elements of the object being scanned together with the surface topology of the object being scanned.” (*Id.*, [0151].)

Fisker teaches that the correlation measure is high an input signal coincides with the reference signal. (Ex.1005, [0074]; Ex.1003, ¶171.) Fisker’s image sensor “provides color registration at each element,” based on the amplitude of light received at each of the sensor elements. (Ex.1005, [0151]-[0157]; Ex.1003, ¶176.) The amplitude is determined for at least one color at every focal plane position. (*Id.*, [0158].) So, at every focus position, the amplitude of light received at the sensor elements is used to compute the maximum of the correlation measure function, to determine surface topology and the surface color, e.g., an RGB color coordinate, for each surface element. (Ex.1003, ¶176.) This surface color is reconstructed by appropriate weighting of the image sensor amplitude signal for each color corresponding to the maximum correlation function. (Ex.1005 , [0151]-[0158], [0279]; Ex.1003, ¶176.) Thus, Fisker teaches this claim. (Ex.1003, ¶¶170-177.)

- H. Claim 9: “The focus scanner according to claim 8, wherein the data processing system is configured for deriving the sub-scan color for a point on a generated sub-scan based on the surface color information of the 2D images in the series in which the correlation measure has its maximum value for the corresponding block of image sensor pixels and on at least one additional 2D image.”**

Fisker teaches a data processing system configured for deriving the sub-scan color for a point on a generated sub-scan using a correlation measure. (Sections VII.A.7-8, VII.D-E, G.) Fisker’s scanner is “adapted to *obtain the color* of the surface being scanned, i.e. capable of registering the color of the individual surface elements of the object being scanned together with the surface topology of the object being scanned.” (Ex.1005, [0151].)

Fisker’s scanner is further configured to determine the “amplitude of the light signal of each of a plurality of the sensor elements...for each color *for each focal plane positions*.” (*Id.*, [0157] and [0280].) In accordance with Fisker’s method, the color of the surface being scanned is “obtained by combining and/or weighing the color information from a plurality of the sensor elements” and the “RGB color coordinate of each surface element can be reconstructed *by appropriate weighting of the amplitude signal for each color corresponding to the maximum amplitude*.” (*Id.*) Then, the color of the surface being scanned may be obtained by interpolating the color information from full-color focal plane positions. (*Id.*, [0158], [0279]-[0280].)

Because Fisker's method includes reconstructing the surface color using an appropriate weighting corresponding to the maximum amplitude and because the color is determined by interpolating the color information from multiple focal plan positions, Fisker teaches this claim. (*Id.*, [0157]-[0158], [0279]-[0280]; Ex.1003, ¶181.)

I. Claim 10: “The focus scanner according to claim 9, where the data processing system is configured for interpolating surface color information of at least two 2D images in a series when determining the sub-scan color.”

Fisker further teaches that “[o]ne specific embodiment of the invention only registers the amplitude for all colors at an interval of P focus positions.” (Ex.1005, [0280.]) Using the information at each focal position, the “[c]olor of each surface element of the probed object is determined by interpolation between the focus positions where full color information is obtained.” (*Id.*) Fisker's disclosure of interpolating the surface color information between the focus positions teaches this claim. (Ex.1003, ¶¶183-184.)

J. Claim 15: “The focus scanner according to claim 1, where the color image sensor comprises a color filter array comprising at least three types of colors filters, each allowing light in a known wavelength range, W1, W2, and W3 respectively, to propagate through the color filter.”

Like the '244 Patent, Fisker teaches a color image sensor. (Section VII.A.3.) Fisker also teaches a color filter array comprising at least three types of color filters. For example, Fisker teaches that to provide color information, “the array of

sensor elements may be a color image sensor. The image sensor may accommodate a Bayer color filter scheme.” (Ex.1005, [0152].) It is known in the art that a Bayer color filter scheme includes three types of color filters—red, green, and blue. (Ex.1003, ¶185.)

Fisker further teaches that when a white light source is used, then some kind of filtering must be provided at the color image sensor to detect color, the filters “[p]referably comprising *a plurality of color filters, such as red, green and blue color filters.*” (Ex.1005, [0153].) Thus, Fisker teaches at least three types of colors filters, each allowing light in a known wavelength range. (Ex.1003, ¶186.)

The ’244 Patent provides up to six different color filters (red, green, blue, cyan, magenta, and yellow) but is silent regarding which color corresponds to each of wavelengths W1, W2, and W3. (Ex.1001, 7:30-32.) In any event, Fisker’s Bayer color filter scheme of red, green, and blue filters teach or suggest three different wavelengths (W1, W2, and W3). (Ex.1003, ¶187; Ex.1005, [0158].) Thus, Fisker teaches this claim.

K. Claim 16: “The focus scanner according to claim 15, where the surface geometry information is derived from light in a selected wavelength range of the spectrum provided by the multichromatic light source.”

Fisker teaches that “the focus position is calculated by determining the light oscillation amplitude for each of a plurality of sensor elements for a range of focus

planes.” (Ex.1005, [0029].) Thus, the light amplitude is measured to determine surface geometry. (Ex.1003, ¶189.) Fisker further teaches that one color of light (i.e., within a selected wavelength range of the spectrum) may be selected to determine the amplitude at all focus positions. (Ex.1005, [0155], [0157], [0280], (“[o]ne specific embodiment of the invention only registers the amplitude for all colors at an interval of P focus positions; while one color is selected for determination of the amplitude at all focus positions.”).) The amplitude measurements collected using the selected color of light is used to determine the surface geometry of the scanned object. (Ex.1003, ¶189.) Thus, Fisker teaches this claim. (Ex.1003, ¶190.)

L. Claim 18: “The focus scanner according to claim 16, wherein the selected wavelength range matches the W2 wavelength range.”

Like the '244 Patent, Fisker does not specify any specific wavelength for the W2 wavelength range. (Ex.1003, ¶191.) But Fisker does teach that the surface geometry information is derived from light in a selected wavelength range. (Section VII.K.) Fisker teaches that one color wavelength may be selected to determine the amplitude at all focus positions. (Ex.1005, [0280] (“one color is selected for determination of the amplitude at all focus positions.”).) Thus, the one selected wavelength of Fisker as a selected wavelength matching the W2 wavelength and thus Fisker teaches this claim. (Ex.1003, ¶192.)

- M. Claim 21: “The focus scanner according to claim 3, where the information of the saturated pixel in the computing of the pattern generating element is configured to provide that the spatial pattern comprises alternating dark and bright regions arranged in a checkerboard pattern.”**

Fisker teaches a pattern generating element configured for incorporating a spatial pattern in said probe light. (Section VII.C.) Fisker further teaches that the illuminated pattern may be “a static checkerboard pattern” having dark and light (i.e., bright) regions. (Ex.1005, [0023]; Ex.1003, ¶193.)

For example, Fisker’s Figure 3c illustrates “a static pattern as applied in a spatial correlation embodiment of this invention.” (Ex.1005, [0249].) Fisker continues, “the checkerboard pattern shown is preferred because calculations for this regular pattern are easiest.” (*Id.*)

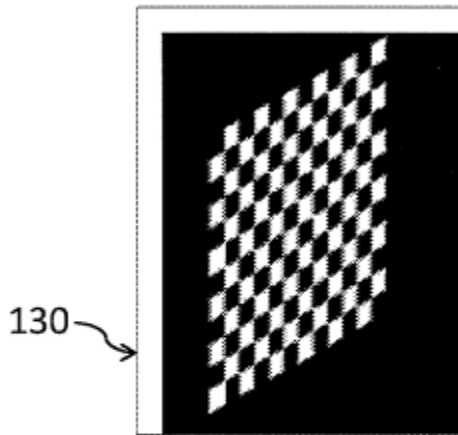


Fig. 3c

(Ex.1005, Fig. 3c.)

Fisker's dark and light checkerboard pattern teaches alternating dark and bright regions arranged in a checkerboard pattern. (Ex.1003, ¶¶194-195.) Thus, Fisker teaches this claim. (Ex.1003, ¶195.)

N. Claim 22

1. [22.P]: “A method of recording surface geometry and surface color of an object”

Fisker discloses a “method for obtaining and/or measuring the 3D geometry of at least a part of the surface of an object.” (Ex.1005, claim 138.) Fisker also discloses a “means for recording and/or integrating and/or monitoring and/or storing” the information collected at each of the sensor elements over a range of focus plane positions. (Ex.1005, [0114].) Fisker further teaches a method for “registering the color of the individual surface elements of the object being scanned together with the surface topology of the object being scanned.” (*Id.*, [0151].) Thus, Fisker teaches the preamble of this claim. (Ex.1003, ¶197.)

2. [22.1]: “obtaining a focus scanner according to claim 1”

The '244 Patent is unclear how or who obtains the focus scanner. (Ex.1003, ¶199.) The plain and ordinary meaning of “obtaining a focus scanner” would be to gain possession of a scanner somehow. (Ex.1003, ¶199.)

Both the '244 Patent and Fisker disclose a handheld device that can be held, manipulated, or obtained by a user. For example, the '244 Patent discloses a “handheld part of a scanner system with components inside a housing 100.”

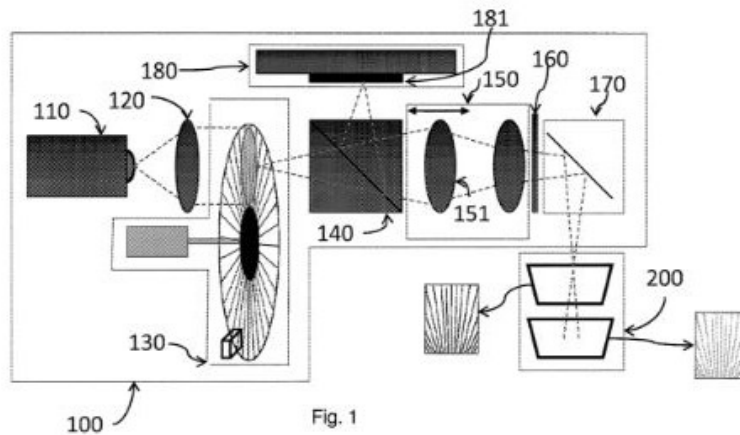
(Ex.1001, 15:63-64.) Likewise, Fisker teaches “a scanner which may be integrated in a manageable housing, such as a handheld housing” that “rests comfortably inside the hand of the operator.” (Ex.1005, [0009], [0174].) Thus, Fisker teaches this limitation.

3. Limitations [22.2]-[22.4]

Limitations [22.2]-[22.4] are substantially similar to limitations [1.1]-[1.4.b] above. (Ex.1003, ¶¶202-216; Appendix A.) The difference being that claim elements [22.2]-[22.4] are written as method steps (in gerund form), whereas claim 1 recites apparatus features and corresponding functionalities. (Ex.1003, ¶196.) Thus, Fisker teaches these limitations for at least the reasons described above. (Sections VII.A.1-7; Ex.1003, ¶¶204, 208, 216.)

O. Claim 24: “The focus scanner according to claim 1, wherein the multichromatic light source, the color image sensor, and at least a portion of the data processing system are included in a hand held unit.”

Fisker teaches a “hand-held scanner with all components inside the housing (head) 100.” (Ex.1005, [0244].) As illustrated in Figure 1, Fisker’s scanner includes, “a light source 110” and “an image sensor and electronics 180.” (*Id.*)



(Ex.1005, Fig. 1.) Fisker later describes the scanner electronics as “processing electronics” (*id.*, [0170]) and describes a real-time image processing, using the “camera electronics” to “discriminate out-of-focus information” (*id.*, [0074]; Ex.1003, ¶217.). Thus, Fisker teaches this claim. (Ex.1003, ¶218.)

P. Claim 26: “The focus scanner according to claim 9, wherein said at least one additional 2D image comprises a neighboring 2D image from the series of captured 2D images.”

Fisker discloses registering color data for at least one color at all focus positions. (Ex.1005, [0158], [0280]; Sections VII.A.4-5 and VII.G-H.) Fisker’s color information is then provided by data interpolation. (*Id.*) Thus, the color of the surface being scanned may be obtained by interpolating the color information from multiple focal plane positions. (*Id.*) This data interpolation technique would include a neighboring 2D image from the series of captured 2D images because a neighboring 2D image, of the images captured from multiple focal plane positions,

would provide more accurate color information. (Ex.1003, ¶219.) Thus, Fisker teaches this claim. (Ex.1003, ¶220.)

Q. Claim 28: “The focus scanner according to claim 10, where the interpolation is of surface color information of neighboring 2D images in a series.”

Fisker discloses registering color data for at least one color at all focus positions. (Ex.1005, [0158], [0280]; Sections VII.A.4-5 and VII.G-I.) Fisker’s color information is then provided by data interpolation. (*Id.*) Thus, the color of the surface being scanned is obtained by interpolating the color information from multiple focal plane positions. (*Id.*) Data interpolation techniques include a neighboring 2D image from the series of captured 2D images because a neighboring 2D image of the images captures from multiple focal plane positions, would provide more accurate color information. (Ex.1003, ¶221.) Thus, Fisker teaches this claim. (Ex.1003, ¶222.)

VIII. Grounds 3 and 4: The combinations of Fisker and Yamada (Ground 3) and Fisker and Suzuki (Ground 4) render claim 29 obvious.

A. Claim 29

1. Limitations [29.P]-[29.4.b]:

Elements [29.P]-[29.4.b] are identical to limitations [1.P]-[1.4.b] above. (Ex.1003, ¶¶226, 229, 232, 236, 240; Appendix A.) Claim 29 was added as a new claim during prosecution to presumably include element [29.5], taken from claim 12, which the Examiner indicated to be allowable subject matter in the only office

action cited against the '244 patent. (Ex.1002, 875, 905.) Thus, Fisker teaches limitation [29.P]-[29.4.b] for at least the reasons described above. (Section VII.A.1-7; Ex.1003, ¶¶228, 231, 235, 239, 247.)

2. [29.5]: “where the data processing system further is configured to detecting (sic) saturated pixels in the captured 2D images and for mitigating or removing the error in the derived surface color information or the sub-scan color caused by the pixel saturation.”⁹

a) Fisker

Fisker explains that objects having a shiny or metallic-looking surface are difficult to scan and often create saturated image. (Ex.1005, [0277]; Ex.1003, ¶248.) While Fisker provides a passive method for mitigating image saturation by preferential imaging of the diffuse surface reflection from the object on the camera using a polarizing beam splitter (Ex.1005, [0277]), Fisker does not disclose a method for detecting a saturated pixel. (Ex.1003, ¶248.)

⁹ During prosecution, the Examiner found that Fisker taught claim limitations [29.P]-[29.4.b]. Claim limitation [29.5] never faced a rejection during prosecution and was added to overcome Fisker. (Ex.1002, 875, 905.) The Examiner never considered Yamada or Suzuki for this or any other claim. This subject matter is also recited in dependent claim 12. But based on the arguments herein, the Examiner should not have found this feature allowable.

Detecting and mitigating errors in surface color information caused by saturated pixels in captured 2D images were known in the art, e.g., as evidenced by Yamada (Ground 3) and Suzuki (Ground 4). (Ex.1003, ¶249.)

b) Yamada (Ground 3)

Yamada discloses a method for correcting false color caused by chromatic aberration, such as false-color pixels caused by pixel saturation, and for generating and outputting high-quality image data. (Ex.1008, Abstract.) Specifically, Yamada's image processing apparatus includes "a white-saturation detection unit for detecting a white saturated pixel from image data." (*Id.*, [0011].) Yamada teaches a saturation detecting step, which is "a step of executing processing for selecting a white-saturated pixel having a luminance higher than or equal to a predetermined threshold." (*Id.*, [0036].)

After a saturated pixel has been detected, Yamada mitigates the error caused by the saturation using pixel-value correction. (*Id.*, [0030]-[0032].) Yamada's pixel-value correcting step is a step of selecting pixels, other than the false-color pixels or the white-saturated pixels, from pixels that exist the neighborhood of white-saturated pixels and executing compensation interpolation processing based on the selected pixels. (*Id.*, [0030]-[0032], [0085].) Thus, Yamada teaches detecting saturated pixels and then mitigating the error in the sub-scan color caused

by the pixel saturation. Thus, the combination of Fisker and Yamada teaches this limitation. (Ex.1003, ¶252.)

c) Suzuki (Ground 4)

Suzuki discloses a digital camera imaging unit that specifies (i.e., detects) a position of a defective pixel, such as a white defect (i.e., saturated pixel), among a plurality of pixels. (Ex.1009, Abstract, [0058].) Suzuki's camera further includes a region specification unit that specifies a region in the image data in which image noise occurs due to the defective (i.e., saturated) pixel. (*Id.*, Abstract, [0063]-[0065].) Suzuki's camera also includes a correction unit that corrects a pixel value of each of the pixels in the region based on a weighted average of pixels values of a plurality of pixels located at a periphery of the region. (*Id.*, Abstract, [0066]-[0069].)

Suzuki teaches a data processing system configured to detecting saturated pixels in the captured 2D images and for mitigating or removing the error in the sub-scan color caused by the pixel saturation. (Ex.1003, ¶254.) As such, Suzuki teaches detecting saturated pixels and then mitigating the error in the sub-scan color caused by the pixel saturation. Thus, the combination of Fisker and Suzuki teaches this limitation. (Ex.1003, ¶255.)

**d) Motivation to Combine: Fisker and Yamada (Ground 3)
and Fisker and Suzuki (Ground 4)**

Fisker, Yamada, and Suzuki are analogous art because they each use a processing means (or computing system) to analyze and process captured images, as does the challenged '244 Patent. (Ex.1003, ¶256.) Each is directed to a computer system for constructing and rendering 3D images. (Ex.1005, [0001]; Ex.1008, [0001]; Ex.1009, Abstract.) And each is similarly concerned with image quality. (Ex.1003, ¶256.)

A POSITA would have been motivated to make the minor modification required to Fisker's image processing method to include Yamada's and Suzuki's similar pixel correction method. (Ex.1003, ¶257.) The resulting combination is little more than the use of a known image processor and known image processing technique to improve image quality—e.g., produce a more accurate and clear image in the presence of one or more defective/saturated pixels. (Ex.1003, ¶257.) A POSITA thus would have improved image processing systems and methods, like Fisker's, in the same way that Yamada suggests—namely, detecting saturated pixels, false-color pixels, and then correcting the pixel values using an interpolation process based on surrounding pixels (Ex.1008, [0030]-[0032]; Ex.1003, ¶257) and in the same way that Suzuki suggests—specifying a defective pixel and correct the pixel value of each defective pixel in the region, based on a

weighted average of pixels values of a plurality of pixels located at a periphery of the region. (Ex.1009, Abstract, [0063]-[0069]; Ex.1003, ¶257.)

And after the combination, each feature would continue to function as intended. *KSR Int'l. Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007).

Fisker recognized the difficulty in scanning shiny or metallic-looking surfaces. (Ex.1005, [0277].) While Fisker provides a passive method for mitigating image saturation, that a shiny or metallic-looking surface may potentially cause, using a polarizing beam splitter, Fisker does not have a method for detecting and/or correcting errors that occur as a result of the increased intensity of reflected light. (Ex.1003, ¶258.) Saturated pixels not only have a whitening effect on an image, but the surrounding pixels also display a false color. (Ex.1008, [0003]; Ex.1009, [0058].) To produce a high-quality image, a POSITA would have been motivated to find additional methods for reducing and/or overcoming pixel saturation. (Ex.1003, ¶258.)

With respect to Yamada, a POSITA would have modified and enhanced Fisker's image processor and known image processing technique with that of Yamada to detect a white-saturation pixel, a false-color pixel, and to correct the image data to generate and output a high-quality image without affecting the entire image. (Ex.1008, Abstract; Ex.1003, ¶259.)

With respect to Suzuki, a POSITA would have modified and enhanced Fisker's image processor and known image processing technique with that of Suzuki to improve image processing efficiency and produce a more accurate image. (Ex.1009, [0011]-[0013].)

The '244 Patent, Fisker, Yamada, and Suzuki are concerned with providing clear and accurate images. As described, a POSITA would have understood the advantages of enhancing Fisker's image processor and known image processing techniques of Yamada and Suzuki. (Ex.1003, ¶260.) Thus, the benefits of employing a Yamada-like method and a Suzuki-like method for processing images in an image processor, such as that of Fisker, would have thus been predictable to a POSITA. *KSR*, 550 U.S. at 417. (Ex.1003, ¶261.)

As provided above, Fisker's image processor and method for processing images would have benefited from Yamada's and Suzuki's methods for detecting defective pixels and correcting the pixel errors. (Ex.1003, ¶262.) Fisker teaches "a computer program product comprising program code means for causing a data processing system to perform the method, when said program code means are executed on the data processing system." (Ex.1005, [0192].)

Similarly, Yamada explains that its methods may be controlled or implemented using a computer program that is executed by a general-purpose

computer system that can execute various program codes via storage media.

(Ex.1008, [0048].)

And Suzuki explains that its methods may be carried out on “a computer capable of executing various functions by installing various programs, for example, a general-purpose personal computer.” (Ex.1009, [0136].)

Based on the foregoing, and a POSITA’s experience, a POSITA would have understood that the method for processing images, as described in the ’244 Patent, Fisker, Yamada, and Suzuki is conducted based on computer programs/software using a processing means. (Ex.1003, ¶263.) Thus, to achieve the benefits of Yamada’s and Suzuki’s image processing modules, it would have been obvious to enhance Fisker’s software (and algorithms) using routine coding and engineering practices. (Ex.1003, ¶263.) Therefore, a POSITA would have been motivated to enhance Fisker’s method for processing images to include the methods of Yamada and Suzuki (Ex.1003, ¶263.)

Finally, a POSITA would have had a reasonable expectation of success when enhancing Fisker’s image processing method with that of Yamada and Suzuki. (Ex.1003, ¶264.) As Dr. Bajaj explains, such a modification would have been a routine matter for a POSITA, because implementing Yamada’s method would not require any additional hardware and could be implemented within

Fisker's data processor by adding to, or altering, the computer code that controls the image processing algorithms. (Ex.1003, ¶264.)

* * *

For at least the foregoing reasons, a POSITA would have found it obvious to enhance Fisker's image processing methods and systems with the methods of Yamada or Suzuki and that the combinations of Fisker and Yamada (Ground 3) and Fisker and Suzuki (Ground 4) teach this limitation. (Ex.1003, ¶265.)

IX. Grounds 5-8: The combinations of Fisker, Szeliski, and Yamada (Ground 5), Fisker, Szeliski, Suzuki (Ground 6), Fisker, Matsumoto, and Yamada (Ground 7), and Fisker, Matsumoto, and Suzuki (Ground 8) render claim 12 obvious.

A. Claim 12: “The focus scanner according to claim 1, wherein the data processing system is configured for detecting saturated pixels in the captured 2D images and for mitigating or removing the error in the derived surface color information or the sub-scan color caused by the pixel saturation.”

Claim 12 is substantially similar to limitation [29.5], except claim 12 recites “wherein” and “configured for” in place of [29.5]’s recitation of “where” and “configured to,” respectively. (Ex.1003, ¶266.) Thus, the same prior art teachings described in Section VIII.A.2.a-c similarly apply here. (Ex.1003, ¶266.) Because claim 12 depends from claim 1, however, the references used to show the unpatentability of claim 1 are included in these Grounds.

Accordingly, a POSITA would have been motivated to combine Fisker, Szeliski, and Yamada or Suzuki and Fisker, Matsumoto, and Yamada or Suzuki for

at least the reasons described above. For example, Yamada and Suzuki's teaching could be implemented within Fisker's data processor by adding, or altering, the computer code that controls the image processing algorithms. (Sections VII.A.11.d and VIII.A.2.d; Ex.1003, ¶276.)

Thus, the combinations of Fisker, Szeliski, and Yamada (Ground 5), Fisker, Szeliski, and Suzuki (Ground 6), Fisker, Matsumoto, and Yamada (Ground 7), and Fisker, Matsumoto, and Suzuki (Ground 8) teach claim 12 for at least the reasons described in Sections VIII.A.2.a-c. (Ex.1003, ¶277.)

X. Grounds 9 and 10: The combinations of Thiel425, Thiel576, and Szeliski (Ground 9) and Thiel425, Thiel576, and Matsumoto (Ground 10) render claims 1, 22, and 24 obvious.

A. Claim 1

1. [1.P]: "A focus scanner for recording surface geometry and surface color of an object"

a) Thiel425

Thiel425 teaches a handheld dental camera (focus scanner) for performing optical 3D object measurements (surface geometry). (Ex.1012, [0013].) The focus scanner comprises a polychromatic light source emitting an illuminating beam onto an object's surface, a scanning unit for changing the focal depths of the illuminating beam as required for chromatic confocal measurements, and a color sensor for capturing each of the wavelengths of the reflected light from the object's surface and configured to determine the optical 3D measurement. (*Id.*, [0085]).

Thiel425 further teaches that each chromatic depth range overlaps, such that the color sensor receives data sets of different chromatic depth ranges that at least partially overlap (a stack of 2D images). (*Id.*, [0013]-[0014], [0023].)

Thus, although Thiel425 teaches capturing a stack of 2D images derived from wavelengths having different focus depths being emitted onto the object and determining the surface geometry of the object therefrom, it does not explicitly disclose determining surface color of the 3D object. However, it would have been obvious to a POSITA to determine both the geometry and colorimetric measurements of the 3D object from the stack of 2D color images at two different focus depths, e.g., in view of Thiel576.

b) Thiel576

Thiel576 teaches a device (focus scanner) comprising a polychromatic light source for emitting a broad-band illuminating beam on an object and an objective for focusing the illuminating beam at two focus depths, one on the object's surface and the other along the optical axis but out of the plane of the object's surface, such that out-of-focus images in the form of a fuzzy circle are reproduced on the object surface plane. (Ex.1013, [0008], [0016], [0087].) The focus scanner also comprises a color sensor for receiving a beam reflected from the object's surface that is used to determine the surface color measurements (surface color). (Ex.1013, [0018].)

As such, it would have been obvious to a POSITA to enhance the spectral analysis and imaging processing methods of Thiel425's device to determine the object's surface color as taught in Thiel576, since Thiel425 already considers sensing and processing of multiple colors (wavelengths) at different focal depths. (Ex.1003, ¶432.) Thus, the combination of Thiel425 and Thiel576 teaches or suggests this preamble. (Ex.1003, ¶433.)

c) Motivation to Combine: Thiel425 and Thiel576

Enhancing Thiel425's image processing methods with Thiel576's imaging processing methods would have been obvious to a POSITA.

First, Thiel425 and Thiel576 share the same inventor (i.e., Frank Thiel) and assignee (i.e., Sirona Dental Systems GmbH). Thiel425 and Thiel576 were also filed in Germany less than two months apart. As such, given the same assignee, the same inventor, and the closeness of filings, a POSITA would have naturally been led from Thiel425 and Thiel576 and vice-versa.

Second, Thiel425 and Thiel576 are each directed to providing clear and accurate images of teeth and complement each other. Thiel425 and Thiel576 are both directed to dental devices and methods for performing optical 3D teeth measurements. (Ex.1012, [0002], [0015], [0043]; Ex.1013, [0002]-[0005], [0066], [0106]). Thiel425 specifically teaches its device "is particularly suitable for producing dental intraoral images of teeth." (Ex.1012, [0015].) Thiel576

specifically teaches that its methods particularly facilitate imaging of teeth in a patient's oral cavity. (Ex.1013, [0046].)

Third, Thiel425 and Thiel576 are both directed to using handheld chromatic confocal apparatuses and methods to perform optical 3D measurements. Thiel425 teaches a device that provides optical 3D surface measurement using an improved chromatic confocal measuring method, specifically one that is capable of carrying out rapid optical 3D surface measurements of an object. Thiel576 teaches a device having a first mode for optical 3D measurement using a chromatic confocal measuring method. Thus, it would be obvious to a POSITA that both Thiel425 and Thiel576 have similar if not identical color confocal measuring apparatus and perform identical functions, so their color image processing methods are easily combinable .

Fourth, Thiel425 and Thiel576 each provide a component (i.e., a chromatic objective) that controls the focus of the illumination beam when performing optical 3D measurements. (Ex.1012, [0050]; Ex.1013, [0059].) Thiel425 teaches a device that has a scanning unit that focuses an illuminating beam onto an object's surface and permits different chromatic depth measurement ranges with stepwise displacement "so that a first chromatic depth measurement range in a first end position of the scanning unit, and a second chromatic depth measurement range in a second focus position are precisely adjoined in a direction of a measurement

depth, or are partially overlapped.” (Ex.1012, Abstract, [0014].) Thiel576 teaches a device that has an objective which focuses an illuminating beam onto a first plane of the surface of an object to be measured, which beam is also “focused by means of the objective onto a second plane other than the first plane at a distance from the surface of the object.” (Ex.1013, [0008].) As such, it would have been obvious to a POSITA, that both Thiel425 and Thiel576 permit the adjustment of the objective to translate the focus across its optical axis and at different depths from the surface of the 3D object being measured, to obtain a similar stack of color 2D images.

Fifth, Thiel425 and Thiel576 each use a processing means (or computing system) to analyze and process a captured stack of color 2D images in dentistry. (Ex.1012, [0044]; Ex.1013, [0037].) Moreover, each is directed to a computer system for constructing and rendering of 3D images of teeth. (Ex.1012, [0043]; Ex.1013, [0046].) As such, a POSITA would have found it obvious that the method for processing a stack of color 2D images, as described in Thiel425 and Thiel576, is conducted based on computer programs/software using a processing means. Thus, to achieve the benefits of Thiel576’s 3D object surface color estimation image processing modules, it would have been obvious to enhance Thiel425’s color image processing software (and algorithms) for the same 3D object surface color estimation using routine coding and engineering practices.

Sixth, a POSITA would have had a reasonable expectation of success when enhancing Thiel425's image processing method with that of Thiel576. As explained by Dr. Bajaj, such a modification would have been a routine matter for a POSITA. (Ex.1003, ¶440.)

For at least these reasons, a POSITA would have understood how and why to enhance Thiel425's image processor with the image processing techniques of Thiel576. (Ex.1003, ¶441.) The benefits of employing a Thiel425-like method for processing images in an image processor, such as that of Thiel576, would have thus been predictable to a POSITA. (Ex.1003, ¶441.)

* * *

Thus, a POSITA would have found it obvious to enhance Thiel425's image processing methods with the methods of Thiel576 and that the combination of Thiel425 and Thiel576 teaches or suggests the claim preamble. (Ex.1003, ¶442.)

2. [1.1]: “a multichromatic light source configured for providing a multichromatic probe light for illumination of the object”

Thiel425 teaches that the dental camera comprises a polychromatic light source configured to emit “an illuminating beam (8) that can be focused, at least in terms of one wavelength thereof, onto the surface of an object of interest by means of the chromatic objective.” (Ex.1012, [0013]). Thiel 425 further states that

“polychromatic light source 3 has a spectral range of two or more wavelengths.”

(*Id.*, [0080]).

A polychromatic light source and a multichromatic light source each refer to a light source having two or more colors. (Ex.1003, ¶444.) Poly and multi are synonyms, in this context. (Ex.1003, ¶444.) Therefore, Thiel425’s polychromatic light source teaches “a multichromatic probe light for illumination of the object” as recited in in this limitation. (Ex.1003, ¶444.) Thus, Thiel425 teaches or suggests this limitation. (Ex.1003, ¶445.)

3. [1.2]: “a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from said object”

Thiel425 teaches a color sensor (the image sensor), such as a CCD sensor, that is “capable of detecting a wavelength spectrum and of reproducing the intensity of the individual wavelength (2D image).” (Ex.1012, [0085].) Thiel425’s CCD camera suggests a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from the object because CCD sensors typically utilize a color filter array. (Ex.1003, ¶¶446-449; Ex.1011, [0001].) Thus, Thiel425 teaches or suggests this limitation. (Ex.1003, ¶450.)

4. **[1.3.a]: “wherein the focus scanner is configured to operate by translating a focus plane along an optical axis of the focus scanner”**

Thiel425 teaches that “[t]he scanning unit 20 is a unit that is moved [translated] in the direction of the arrow 21 within the handheld dental camera 1 along the longitudinal axis A [optical axis] of the handheld dental camera 1, for example, by means of an electronically controlled electric motor, so that the focal points 13, 14 of the illuminating beam 8 are moved along the z axis.” (Ex. 1012., [0084]; Ex.1003, ¶451.)

Thiel425’s use of a motor to move the scanning unit 20 along the longitudinal axis A of the camera teaches “translating a focus plane along an optical axis of the focus scanner” as recited in part this limitation. (Ex.1003, ¶452.) Thus, Thiel425 teaches or suggests this limitation. (Ex.1003, ¶453.)

5. **[1.3.b]: “wherein the focus scanner is configured to operate by...capturing a series of the 2D images, each 2D image of the series is at a different focus plane position such that the series of captured 2D images forms a stack of 2D images”**

Thiel425 teaches that by means of the scanning unit, the handheld dental camera (focus scanner) provides focal points of different wavelengths over various depth measurement ranges of the object that can adjoin or overlap each other (a stack of 2D images) along the z-axis of the object (different focus plane positions) and be measured successively. (Ex.1012, [0013]). Thus, Thiel425 teaches or suggests this limitation. (Ex.1003, ¶¶454-455.)

6. [1.4.a]: “a data processing system configured to derive surface geometry information for a block of said image sensor pixels from the 2D images in the stack of 2D images captured by said color image sensor”

In view of the '244 Patent, a “block” or “group” of sensor pixels includes all sensor pixels in the array of sensor pixels or a subset thereof. (Section VII.A.6; Ex.1003, ¶456.)

Thiel425 teaches the chromatic objective keeping the focal points of the illuminating beam apart and thus forming a chromatic depth measurement range. (Ex.1012, [0083].) Thiel425 further teaches that the scanning unit moves the illuminating beam onto the object's surface within the chromatic depth measurement range and that datasets are received at each chromatic depth measurement range. (Ex.1012, [0084].) Thiel425 further teaches that the chromatic depth measurement ranges can be overlapping. (*Id.*)

Thiel425 also teaches that a data processing unit (data processing system) in communication with a color sensor (color image sensor) that receives successive data sets (2D images) for different chromatic depth measurement ranges are saved and combined (stack of 2D images) to form a 3D data set of the object of interest. (Ex.1012, [0085]; Ex.1003, ¶458.) Thiel425 teaches that this can permit determination of a z value (surface geometry information) for a point on an x-y plane of an object of interest. (Ex.1012, [0082], [0085]; Ex.1003, ¶458.)

Thus, Thiel425 teaches or suggests this limitation. (Ex.1003, ¶459.)

7. [1.4.b]: “the data processing system also configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information”

a) Thiel425

Thiel425’s data processing system in communication with its color image sensor (Section X.A.6.) and derives a stack of 2D images from data received by the color image sensor (Section X.A.1.a). Thiel425 further teaches a stack of 2D images derived from wavelengths having different focus depths being emitted onto the object. (Section X.A.1.a.)

Thus, although Thiel425 teaches determining surface geometry information of the object of interest from an image in the stack of 2D images (Section X.A.6.), it does not explicitly disclose determining surface color information of the object of interest from at least one of the images in the stack of 2D images. However, it would have been obvious to a POSITA to determine surface color information from at least one image in the stack of 2D images of Thiel425, e.g., in view of Thiel576. (Ex.1003, ¶461.)

b) Thiel576

Thiel576 teaches a device (focus scanner) that emits a broad-band illuminating beam on an object and an objective for focusing the illuminating beam at two focus depths, one on the object’s surface and the other along the optical axis

but out of the plane of the object's surface, such that out-of-focus images in the form of a fuzzy circle are reproduced on the object surface plane. (Section X.A.1.b.) Thiel576 further teaches that the device receive beam reflected from the object's surface that is used to determine the surface color measurements (surface color information). (*Id.*)

As such, it would have been obvious to a POSITA to enhance the spectral analysis and imaging processing methods of Thiel425's device to derive surface color measurements a color information simultaneous to its deriving surface geometry information in view of Thiel576, since Thiel425's device already operates on the stack of 2D color images (at least one of the 2D images used to derived the surface geometry information) derived from different focal depths. (Ex.1003, ¶463.) Thus, the combination of Thiel425 and Thiel576 teaches or suggests this limitation.

c) Motivation to Combine: Thiel425 and Thiel576

Enhancing Thiel425's imaging processing methods with Thiel576's imaging processing methods would have been obvious to a POSITA for the same reasons as described in Section X.A.1.c. (Ex.1003, ¶464.)

Specifically, it would have been obvious to a POSITA that both Thiel425 and Thiel576 permit the adjustment of the objective to translate the focus across its optical axis and at different depths from the surface of the 3D object being

measured, to obtain a similar stack of color 2D images. (Section X.A.1.c; Ex.1003, ¶438.)

Moreover, a POSITA would have understood that Thiel425's illuminating beam can be utilized to derive surface color, e.g., as in Thiel576. Thiel425 teaches a light source providing an illumination beam having a spectral range of 300 nm to 2000 nm. (Ex.1012, [0057].) Thiel576 teaches a light source providing an illuminating beam having a spectral range of 400 nm to 800 nm. (Ex.1013, [0014].) As such, it would have been obvious to a POSITA that the illuminating beam of Thiel425 can be utilized to derive surface color information ,e.g., as taught by Thiel576, in addition to surface geometry information.

For at least these reasons, a POSITA would have understood how and why to enhance Thiel425's image processor with the image processing techniques of Thiel576. (Ex.1003, ¶466.) The benefits of employing a Thiel425-like method for processing images in an image processor, such as that of Thiel576, would have thus been predictable to a POSITA. (Ex.1003, ¶466.)

* * *

Thus, a POSITA would have found it obvious to enhance Thiel425's image processing methods with the methods of Thiel576 and that the combination of Thiel425 and Thiel576 teaches or suggests this limitation. (Ex.1003, ¶464.)

8. **[1.5.a]: “wherein the data processing system further is configured to combining [sic] a number of sub-scans to generate a digital 3D representation of the object”**

Thiel425’s data processing system in communication with its color image sensor. (Section X.A.6.) Thiel425 further teaches that “[t]he color sensor 4 [...] is capable of detecting a wavelength spectrum and of reproducing the intensity of the individual wavelength. Thus a wavelength-dependent intensity profile of the monitoring beam 8 and thus the wavelength having the maximum intensity is ascertained, from which the elevation value, that is, the z value can be computed.” (Ex.1012, [0085].) Thiel425 further teaches that “the data sets successively acquired for different chromatic depth measurement ranges 15.1-4 in different positions of the scanning unit 20 are saved and combined to form an overall 3D dataset of the object of interest over the total depth measurement range 16.” (*Id.*)

Therefore, two different data sets acquired from different pairs of overlapping chromatic depth ranges of Thiel425 are two sub-scans, and thus Thiel425 teaches “combining [sic] a number of sub-scans to generate a digital 3D representation of the object” as claimed in part in this limitation. (Ex.1003, ¶466.) Thus, Thiel425 teaches or suggests this limitation. (Ex.1003, ¶466.)

9. [1.5.b]: “wherein the data processing system further is configured to ... determining [sic] object color of a least one point of the generated digital 3D representation of the object from sub-scan color of the sub-scans combined to generate the digital 3D representation, such that the digital 3D representation expresses both geometry and color profile of the object”

Thiel425’s data processing system in communication with its color image sensor (section X.A.6.) and that the color image sensor receives datasets from different, overlapping chromatic depth ranges (section X.A.8.). At least two data sets acquired from different, overlapping chromatic depth ranges of Thiel425 is a single “sub-scan” as claimed and thus Thiel425 teaches or suggests “combining [sic] a number of sub-scans to generate a digital 3D representation of the object” as claimed in part by limitation 1.4.b. (Section X.A.8.)

Thiel425/Thiel576 teaches that the datasets of Thiel425 can be utilized to determine geometry and colorimetric measurements of the object. (Sections X.A.1 and X.A.7.) As such, at least two data sets combined to form the digital 3D representation of the object (generated digital 3D representation of the object from sub-scan color of the sub-scans combined to generate the digital 3D representation) of Thiel425 would have at least one point with geometry and colorimetric measurements. (Ex.1003, ¶468.) Thus, the combination Thiel425 of Thiel576 teaches or suggests this limitation. (Ex.1003, ¶468.)

- 10. [1.6]: “wherein determining the object color comprises computing a weighted average of sub-scan color values derived for corresponding points in overlapping sub-scans at that point of the object surface.”**

a) Thiel425/Thiel576

Thiel425 teaches receiving datasets from different overlapping chromatic depth ranges. (Section X.A.8.). Two different data sets acquired from different pairs of overlapping chromatic depth ranges of Thiel425 are two sub-scans. (Section X.A.8.) A POSITA would have understood that Thiel425/Thiel576 teaches each data set having at least one point with geometry and colorimetric measurements. (*Id.*)

Thiel425/Thiel576 do not explicitly disclose determining the object color by computing a weighted average of sub-scan values derived for corresponding points in overlapping sub-scans at that object surface’s point. (Ex.1003, ¶470.)

However, performing this weighted average of overlapping sub-scans was very well known in the art, e.g., as taught by Szeliski (Ground 9) and Matsumoto (Ground 10). (Ex.1003, ¶471.)

b) Szeliski (Ground 9) and Matsumoto (Ground 10)

Szeliski and Matsumoto each teach determining the object color by deriving sub-scan values for corresponding points of overlapping sub-scans at that point of the object structure and computing a weighted average of the sub-scan color values. (Sections VII.A.11.b-c .) Moreover, a POSITA would have been motivated

to combine Thiel425 and Thiel576 with Szeliski and Matsumoto. (Ex.1003, ¶¶488, 490 .) Therefore, the combinations of Thiel425, Thiel576, and Szeliski (Ground 9) and Thiel425, Thiel576, and Matsumoto (Ground 10) teach or suggest this limitation. (Ex.1003, ¶¶488, 490.)

c) Motivation to Combine: Thiel425, Thiel576, Szeliski (Ground 9) and Thiel425, Thiel576, Matsumoto (Ground 10)

Combining the teachings of Thiel425/Thiel576 with Szeliski and Matsumoto would have been obvious to a POSITA for at least the following reasons.

First, like Thiel425/Thiel576, Szeliski and Matsumoto are each directed to providing clear and accurate color images of a 3D object. (Ex.1003, ¶484.) Also, like Thiel425/Thiel576, Szeliski, and Matsumoto are each directed to constructing and rendering 3D object models with color images (textures) and concerned with image quality and alignment. (Ex.1003, ¶484.)

For example, Szeliski teaches a mosaic or “stitching” method for aligning and compositing overlapping images into a 3D model. For example, “for every point in a given triangle of the 3D model, thus defining the pixels in the corresponding triangle in texture space.” (Ex.1006, 30:20-24.) In Szeliski’s step 3250, “for every point in a bounding box surrounding a given triangle in texture space, a mapping to the corresponding pixel in every overlapping image is found,

and those corresponding pixel values (colors or intensities) are blended to form a composited pixel value” based on a weighted average. (Ex.1006, 30:18-24)

Image mosaic stitching/registration methods, like the methods taught by Szeliski, were commonly used in the dental industry to create 3D models. For example, in “Digital Dental Revolution,” a textbook that provides an overview of intraoral scanners and image processing methods, explains that overlapping scans may be stitched together to produce a 3D virtual model. (Ex.1014, 102-103, Figs. 32, 33.)

Similarly, Matsumoto teaches a weighted mean process that is applied to image information (color, density or luminance) and results in improved texture/color information and a 3D model of higher accuracy. (Ex.1007, 5:30-34, 7:48-50.) More specifically, Matsumoto teaches a weighted mean process for images captured from differing viewpoints and using the collected image data to create a 3D model. (*Id.*, 8:32-37; Ex.1003, ¶487.)

Second, a POSITA would have been motivated to enhance Thiel425/Thiel576’s image processing techniques with those of Szeliski’s and Matsumoto’s techniques. (Ex.1003, ¶488.) Thiel425/Thiel576 teaches generating multiple images of the illuminating beam and combining the images produced thereby to create a 3D representation of the object. (Section X.A.8.) However, Thiel425/Thiel576 does not detail a specific way to combine the multiple color

image sub-scans to create the 3D representation of the object and maintain an appropriate color of each pixel in the images. (Ex.1003, ¶488.) Thus, Szeliski's method for computing a blended color as a weighted sum of the colors of corresponding pixels would have been an obvious modification to improve Thiel425/Thiel576. (Ex.1003, ¶488.) Alternatively, Matsumoto's techniques for combining pixels of color by determining their mean value would have also been an obvious modification to improve Thiel425/Thiel576. (Ex.1003, ¶488.) As such, a POSITA would have found it obvious to combine weighted averages, as taught by the teachings of Szeliski or Matsumoto, when combining the sub-scan images to form a 3D representation of the object in Thiel576/425. (Ex.1003, ¶488.)

Third, the combining of the imaging processing techniques of Thiel425/Thiel576 with those of Szeliski's and Matsumoto's techniques would require nothing more than additional processing. (Ex.1003, ¶489.) Thiel425/Thiel576 teach a data processor in communication with a color sensor to analyze 2D images received therefrom. (Section X.A.8.) Similarly, Szeliski explains that its methods are performed by computer systems using "program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks." (Ex.1006, 7:52-54.) Alternatively, Matsumoto explains that "the object extraction apparatus includes a computer 130" and that

“[c]omputer 130 detects and extracts an object portion in the object image according to a program 301.” (Ex.1007, 30:32-34.)

Based on the foregoing, and a POSITA’s experience, a POSITA would have understood that the method for processing images, as described in each of the Thiel425/Thiel576, Szeliski, and Matsumoto, is conducted based on computer programs/software using processing means. (Ex.1003, ¶490.) Thus, to achieve the benefits of Szeliski’s and Matsumoto’s image processing modules, it would have been obvious to enhance Thiel425/Thiel576’s software (and algorithms) using routine coding and engineering practices. (Ex.1003, ¶490.)

Therefore, a POSITA would have been motivated to enhance Thiel425/Thiel576’s method for processing images to include a Szeliski-style method for combining image data from multiple scans, accounting for scanner movement, and determining a scanned object’s color using data from multiple images and a Matsumoto-style method for improving the color and texture continuity of the image data, resulting in more accurate 3D model. (Ex.1003, ¶490.)

Fourth, a POSITA would have had a reasonable expectation of success when enhancing Thiel425/Thiel576’s image processing method with those of Szeliski and Matsumoto. (Ex.1003, ¶491.) Because, as Dr. Bajaj explains, such a modification would have been a routine matter for a POSITA. (Ex.1003, ¶491.)

* * *

For at least the foregoing reasons, a POSITA would have found it obvious to enhance Thiel425/Thiel576's image processing methods with the methods of Szeliski or Matsumoto and that the combinations of Thiel425, Thiel576, and Szeliski (Ground 9) and Thiel425, Thiel576, and Matsumoto (Ground 10) teach or suggest this limitation. (Ex.1003, ¶492.)

B. Claim 22

1. [22.P]: “A method of recording surface geometry and surface color of an object”

Similar to [1.P], Thiel425/Thiel576 teach a method for “recording surface geometry and surface color of an object.” (Section X.A.1.a-b.) And, it would have been obvious to combine the teachings of Thiel425 with those of Thiel576. (Section X.A.1.c.; Ex.1003, ¶493.) Thus, Thiel425/Thiel576 teaches or suggests the preamble of this claim. (Ex.1003, ¶493.)

2. [22.1]: “obtaining a focus scanner according to claim 1”

The '244 Patent is unclear how or who obtains the focus scanner. (Ex.1003, ¶500.) The plain and ordinary meaning of “obtaining a focus scanner” would be to gain possession of a scanner somehow. (Ex.1003, ¶500.)

Both the '244 Patent and Thiel425 discloses a handheld device that can be held, manipulated, or obtained by a user. For example, the '244 Patent discloses a “handheld part of a scanner system with components inside a housing 100.”

(Ex.1001, 15:63-64.) Likewise, Thiel425 teaches “a handheld dental camera” configured to perform “three-dimensional, optical measurements.” (Ex.1012, Abstract, [0047], (“a user cannot hold the camera steadily for more than very short periods of time.”).) Thus, Thiel425 teaches or suggests this limitation. (Ex.1003, ¶501.)

3. Limitations [22.2]-[22.4]

Limitations [22.2]-[22.4] are substantially similar to limitations [1.1]-[1.4.b]. (Ex.1003, ¶¶502, 506, 512; Appendix A.) The difference being that claim elements [22.2]-[22.4] are written as method steps (in ground form), whereas claim 1 recites apparatus features and corresponding functionalities. (Ex.1003, ¶493.) Thus, the combination of Thiel425 and Theil576 teaches or suggests these limitations. (Sections X.A.1-7; Ex.1003, ¶¶505, 511, 515, 517.)

C. Claim 24: “The focus scanner according to claim 1, wherein the multichromatic light source, the color image sensor, and at least a portion of the data processing system are included in a hand held unit.”

Thiel425 teaches that “[t]he handheld dental camera 1 comprises a scanning unit which, in this exemplary embodiment, comprises a chromatic objective 2, a polychromatic light source 3, a pivotal mirror 5, and a beam splitter 6, and which is capable of being moved along the longitudinal axis A within the handheld dental camera 1.” (Ex.1012, [0077].) Thiel425’s handheld dental camera also comprises “a color sensor 4, a deflector 7, for example a deflection mirror, and a

connector 11 to which a data processing unit 12 can be connected.” (*Id.*) Thus, Thiel425 teaches or suggests this claim. (Ex.1003, ¶520.)

XI. Grounds 11 and 12: The combinations of Thiel425, Thiel576, and Yamada (Ground 11) and Thiel425, Thiel576, and Suzuki (Ground 12) render claim 29 obvious.

A. Claim 29

1. Limitations [29.P]-[29.4.b]

Limitations [29.P]-[29.4.b] are identical to limitations [1.P]-[1.4.b]. (Section X.A.1-7; Ex.1003, ¶¶522, 529, 533, 536, 541.) Thus, the Thiel425/Thiel476 combination teaches or suggests limitations [29.P]-[29.4.b] for at least the reasons described above. (Section X.A.1-7; Ex.1003, ¶¶527, 532, 535, 540, 544.)

2. [29.5]: “where the data processing system further is configured to detecting (sic) saturated pixels in the captured 2D images and for mitigating or removing the error in the derived surface color information or the sub-scan color caused by the pixel saturation.”

a) Thiel425/Thiel576

Thiel425’s data processing system in communication with its color image sensor (Section X.A.6.) and derives a stack of 2D images from data received by the color image sensor (Section X.A.1.a). Thiel425/Thiel576 teaches or suggests deriving surface color from the stack of 2D images of Thiel425. (Section X.A.7.)

Thiel425/Thiel576 does not explicitly disclose detecting saturated pixels in the 2D images and mitigating or removing errors in the derived surface color

information or the sub-scan color caused by the pixel saturation. (Ex.1003, ¶549.)

However, this was known in the art, e.g., as explicitly taught by Yamada (Ground 11) or Suzuki (Ground 12). (Ex.1003, ¶549.)

b) Yamada (Ground 11) and Suzuki (Ground 12)

Yamada and Suzuki each teach limitation [29.5]. (Sections VIII.A.2.b-c.)

The same teachings apply here.

c) Motivation to Combine: Thiel425, Thiel576, and Yamada (Ground 11) and Thiel425, Thiel576, and Suzuki (Ground 12)

Combining the teachings of Thiel425/Thiel576 with Yamada and Suzuki would have been obvious to a POSITA for at least the following reasons.

First, like Thiel425, Thiel576, Yamada, and Suzuki are each directed to providing clear and accurate color images of an object. (Ex.1003, ¶555.) Also, like Thiel425, Thiel576, Yamada, and Suzuki are each directed to constructing and rendering 3D images and concerned with image quality and alignment. (Ex.1003, ¶555.)

Second, a POSITA would have been motivated to enhance Thiel425/Thiel576's image processing techniques with those of Yamada's and Suzuki's techniques. (Ex.1003, ¶556.) Thiel425/Thiel576 teaches generating multiple images by adjusting the focal length of the illuminating beam and combining the images to create a 3D representation of the object. (Section X.A.9.)

However, Thiel425/Thiel576 do not account for image saturation. Thus, Yamada's method for mitigating detected saturation caused in pixels of images would have been an obvious modification to improve Thiel425/Thiel576. (Ex.1003, ¶556.) Moreover, Suzuki's techniques for resolving false color caused by chromatic aberration, as used in Thiel425/Thiel576, would have been an obvious modification to improve Thiel425/Thiel576. (Ex.1003, ¶556.) As such, a POSITA would have found it obvious to remove errors, as taught by teachings of Yamada and Suzuki, when combining images to form the 3D representation of the object in Thiel576/425. (Ex.1003, ¶556.)

Third, the combining of the imaging processing techniques of Thiel425/Thiel576 with those of Yamada's and Suzuki's techniques would require nothing more than additional processing. Thiel425/Thiel576 teaches a data processor in communication with a color sensor to analyze 2D images received therefrom. (Section X.A.6.) Similarly, Yamada explains that its methods may be controlled or implemented using a computer program that is executed by a general-purpose computer system that can execute various program codes via storage media. (Ex.1008, [0048].) Alternatively, Suzuki explains that its methods may be carried out on "a computer capable of executing various functions by installing various programs, for example, a general-purpose personal computer." (Ex.1009, [0136].)

Based on the foregoing, and a POSITA's experience, a POSITA would have understood that the method for processing images, as described in each of the Thiel425, Thiel576, Yamada, and Suzuki is conducted based on computer programs/software using processing means. (Ex.1003, ¶558.) Thus, to achieve the benefits of Yamada's and Suzuki's image processing modules, it would have been obvious to enhance Thiel425/Thiel576's software (and algorithms) using routine coding and engineering practices. (Ex.1003, ¶558.) Therefore, a POSITA would have been motivated to enhance Thiel425/Thiel576's method for processing images to include a Yamada-style method for resolving saturation in the images and a Suzuki-style method for resolving false identifications of color. (Ex.1003, ¶558.)

Fourth, a POSITA would have had a reasonable expectation of success when enhancing Thiel425/Thiel576's image processing method with that of either Yamada or Suzuki. (Ex.1003, ¶559.) As Dr. Bajaj explains, such a modification would have been a routine matter for a POSITA. (Ex.1003, ¶559.) For example, Dr. Bajaj states the methods of Yamada or Suzuki would not require any additional hardware and could be implemented within Fisker's data processor by adding, or altering, the computer code that controls the image processing algorithms. (Ex.1003, ¶559.)

* * *

For at least the foregoing reasons, a POSITA would have found it obvious to enhance Thiel425/Thiel576 image processing methods with the methods of Yamada or Suzuki and that the combinations of Thiel425, Thiel576, and Yamada (Ground 11) and Thiel425, Thiel576, and Suzuki (Ground 12) teach or suggest this limitation. (Ex.1003, ¶560.)

XII. Grounds 13 and 14: The combinations of Thiel425, Thiel576, Szeliski, and Fisker (Ground 13) and Thiel425, Thiel576, Matsumoto, and Fisker (Ground 14) render claims 2-5, 7-10, 15, 16, 18, 21, 26, and 28 obvious.

A. Claims 2-5, 7-10, 15, 16, 18, 21, 26, and 28

**a) Thiel425/Thiel576/Szeliski and
Thiel425/Thiel576/Matsumoto**

Thiel425/Thiel576/Szeliski and Thiel425/Thiel576/Matsumoto each teach using sub-scans of an object to create a digital 3D representation of the object. (Sections X.A.8-11; Ex.1003, ¶726.) However, these references do not explicitly disclose the particulars of limitations of claims 2-5, 7-10, 15, 16, 18, 21, 26, and 28. (Ex.1003, ¶726.) Nonetheless, these limitations are well known in the art, e.g., as explicitly taught by Fisker.

b) Fisker

Fisker teaches the limitations of claims 2-5, 7-10, 15, 16, 18, 21, 26 and 28. (Sections VII.B-M, P, Q; Ex.1003, ¶726.)

c) Motivation to Combine: Thiel425, Thiel576, Szeliski and Fisker (Ground 13) and Thiel425, Thiel576, Matsumoto and Fisker (Ground 14)

Enhancing Thiel425/Thiel576/Szeliski's and Thiel425/Thiel576/Matsumoto's image processing methods with those of Fisker would have been obvious to a POSITA for at least the following reasons.

First, like Thiel425, Thiel576, Szeliski, and Matsumoto, Fisker is directed to providing clear and accurate color images of an object. (Ex.1003, ¶686.) Also, like Thiel425, Thiel576, Szeliski, and Matsumoto, Fisker is directed to constructing and rendering 3D images and concerned with image quality and alignment. (Ex.1005, [0263].) For example, Fisker teaches a "fused image" that is generated by "combining all the in-focus regions of the series" of images. Fisker further teaches that the fused image "can be interpreted as the reference signal and the reference vector/set of weight values...for the n pixels in the pixel group..." (*Id.*, [0263]-[0264].) Fisker's color is further "expressed as e.g. an RGB color coordinate of each surface element can be reconstructed by appropriate weighting of the amplitude signal for each color corresponding the maximum amplitude." (*Id.*, [0279].)

Second, a POSITA would have found been motivated to enhance the image processing techniques of Thiel425/Thiel576/Szeliski, and of Thiel425/Thiel576/Matsumoto, with those of Fisker. (Ex.1003, ¶687.)

Thiel425/Thiel576/Szeliski and Thiel425/Thiel576/Matsumoto each teach generating multiple images that each have color information and combine the images by using a weighted average of overlapping points of the images. (Section X.A.10.b.) However, neither Thiel425/Thiel576/Szeliski nor Thiel425/Thiel576/Matsumoto teaches a specific way to align the images when images are combined and to calculate a correlation measure between images and a weight function. (Ex.1003, ¶687.) Thus, the implementation of Fisker's means for pattern generation and for evaluating a correlation measurement at each focus plane position would have been an obvious modification to improve the device of Thiel425/Thiel576/Szeliski and Thiel425/Thiel576/Matsumoto. (Ex.1003, ¶687.)

Third, the combining of the imaging processing techniques of Thiel425/Thiel576/Szeliski, and of Thiel425/Thiel576/Matsumoto, with those of Fisker would require nothing more than additional processing. (Ex.1003, ¶688.) Fisker specifically provides nothing more than a data processing unit for performing its method. (Ex.1005, [0192].)

Based on the foregoing, and a POSITA's experience, a POSITA would have understood that the method for processing images, as described in each of Thiel425, Thiel576, Szeliski, Matsumoto, and Fisker, is conducted based on computer programs/software using processing means. (Ex.1003, ¶689.) Thus, to achieve the benefits of Fisker's image processing modules, it would have been

obvious to enhance the software (and algorithm) of Thiel425/Thiel576/Szeliski's, and of Thiel425/Thiel576/Matsumoto, using routine coding and engineering practices. (Ex.1003, ¶689.) Therefore, a POSITA would have been motivated to enhance the image processing methods of, Thiel425/Thiel576/Szeliski, and of Thiel425/Thiel576/Matsumoto, to include a Fisker-style method for spatial resolution of the 3D representation of the object. (Ex.1003, ¶689.)

Fourth, a POSITA would have had a reasonable expectation of success when enhancing the image processing methods of Thiel425/Thiel576/Szeliski and of Thiel425/Thiel576/Matsumoto, with those of Fisker's. (Ex.1003, ¶690.) As Dr. Bajaj explains, such a modification would have been a routine matter for a POSITA because implementing Fisker's method would not require any additional hardware and could be implemented by adding to, or altering, the computer code that controls the image processing algorithms. (Ex.1003, ¶690.)

* * *

For at least the foregoing reasons, a POSITA would have found it obvious to enhance the image processing methods of Thiel425/Thiel576/Szeliski and Thiel425/Thiel576/Matsumoto with those of Fisker and that the combinations of Thiel425, Thiel576, Szeliski, and Fisker (Ground 13) and Thiel425, Thiel576, Matsumoto, and Fisker (Ground 14) teach or suggest these claims. (Ex.1003, ¶691.)

XIII. Mandatory Notices (37 C.F.R. §42.8(a)(1))

REAL PARTIES IN INTEREST:

The Petitioner and real party-in-interest is Align Technology, Inc.

RELATED MATTERS:

The '244 patent is the subject of the following civil actions: *3Shape A/S v. Align Technology, Inc.* Case No. 1-18-cv-00697 (DED), filed May 8, 2018.

Petitioner is concurrently filing another petition for post-grant review of the '244 Patent (PGR2018-00104), and expects to file two petitions for inter partes review of the '244 Patent (IPR2019-00117 and IPR2019-00118).

Pending U.S. Patent Application No. 15/888,416 claims the benefit of the '244 patent.

LEAD AND BACKUP COUNSEL:

Pursuant to 37 C.F.R. §§42.8(b)(3) and 42.10(a), Petitioner appoints **Robert Greene Sterne** (Reg. No. 28,912) as its lead counsel and **Jason D. Eisenberg** (Reg. No. 43,447), **Salvador M. Bezos** (Reg. No. 60,889), **Trent W. Merrell** (Reg. No. 73,771), and **George L. Howarah** (Reg. No. 72,012) as its backup counsel, all at the address: STERNE, KESSLER, GOLDSTEIN & FOX, 1100 New York Avenue, N.W., Washington, D.C., 20005, phone number (202) 371-2600 and facsimile (202) 371-2540.

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XIV. Conclusion

Based on the grounds specified above, post-grant review of the challenged claims is respectfully requested.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

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CERTIFICATION OF WORD COUNT

The undersigned hereby certifies that the portions of the above-captioned **SECOND CORRECTED PETITION FOR POST-GRANT REVIEW** specified in 37 C.F.R. §42.24 has 18,630 words, in compliance with the 18,700 word limit set forth in 37 C.F.R. §42.24. This word count was prepared using Microsoft Word 2010.

Respectfully submitted,

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CERTIFICATE OF SERVICE (37 C.F.R. § 42.6(e), 42.05(b))

The undersigned hereby certifies that the above-captioned Align
Technology, Inc.'s **SECOND CORRECTED PETITION FOR POST-GRANT
REVIEW** and **SECOND CORRECTED BAJAJ DECLARATION (EX. 1003)**
were served via USPS Express Mail on October 30, 2018, in their entireties on the
following:

Buchanan, Ingersoll & Rooney PC
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9,962,244*

Respectfully submitted,

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Appendix A

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| <u>Claim 1</u> ¹⁰ | <u>Claim 29</u> | <u>Claim 31</u> | <u>Claim 32</u> | <u>Claim 34</u> |
|---|--|--|--|--|
| [1.P]: A focus scanner for recording surface geometry and surface color of an object, the focus scanner comprising: | [29.P]: A focus scanner for recording surface geometry and surface color of an object, the focus scanner comprising: | [31.P]: A focus scanner for recording surface geometry and surface color of an object, the focus scanner comprising: | [32.P]: A focus scanner for recording surface geometry and surface color of an object, the focus scanner comprising: | [34.P]: A focus scanner for recording surface geometry and surface color of an object, the focus scanner comprising: |
| [1.1]: a multichromatic light source configured for providing a multichromatic probe light for illumination of the object, | [29.1]: a multichromatic light source configured for providing a multichromatic probe light for illumination of the object, | [31.1]: a multichromatic light source configured for providing a multichromatic probe light for illumination of the object, | [32.1]: a multichromatic light source configured for providing a multichromatic probe light for illumination of the object, | [34.1]: a multichromatic light source configured for providing a multichromatic probe light for illumination of the object, |
| [1.2]: a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from said object, | [29.2]: a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from said object, | [31.2.a]: a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from said object, | [32.2]: a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from said object, | [34.2]: a color image sensor comprising an array of image sensor pixels for capturing one or more 2D images of light received from said object, |

¹⁰ Claim 22 is an independent method claim for using the focus scanner of claim 1.

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| <u>Claim 1</u> ¹⁰ | <u>Claim 29</u> | <u>Claim 31</u> | <u>Claim 32</u> | <u>Claim 34</u> |
|--|--|--|---|--|
| | | [31.2.b]: where the color image sensor comprises a color filter array comprising at least three types of colors filters, each allowing light in a known wavelength range, W1, W2, and W3 respectively, to propagate through the color filter; | [32.5.a]: where the color image sensor comprises a color filter array comprising at least three types of colors filters, each allowing light in a known wavelength range, W1, W2, and W3 respectively, to propagate through the color filter ¹¹ | |
| [1.3.a]: wherein the focus scanner is configured to operate by translating a focus plane along an optical axis of the focus scanner and [1.3.b] capturing a series of the 2D images, each 2D image of the series is | [29.3.a]: wherein the focus scanner is configured to operate by translating a focus plane along an optical axis of the focus scanner and [29.3.b] capturing a series of the 2D images, each 2D image of the series is | [31.3.a]: wherein the focus scanner is configured to operate by translating a focus plane along an optical axis of the focus scanner and [31.3.b] capturing a series of the 2D images, each 2D image of the series is | [32.3.a]: wherein the focus scanner is configured to operate by translating a focus plane along an optical axis of the focus scanner and [32.3.b] capturing a series of the 2D images, each 2D image of the series is | [34.3.a]: wherein the focus scanner is configured to operate by translating a focus plane along an optical axis of the focus scanner and [34.3.b] capturing a series of the 2D images, each 2D image of the series is |

¹¹ This limitation appears second-to-last in claim 32, but is shown here next to its corresponding limitation from claim 31. All other claim limitations in all claims appear top-to-bottom in the correct order.

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| <u>Claim 1</u> ¹⁰ | <u>Claim 29</u> | <u>Claim 31</u> | <u>Claim 32</u> | <u>Claim 34</u> |
|---|---|---|---|---|
| at a different focus plane position such that the series of captured 2D images forms a stack of 2D images; and | at a different focus plane position such that the series of captured 2D images forms a stack of 2D images; and | at a different focus plane position such that the series of captured 2D images forms a stack of 2D images; and | at a different focus plane position such that the series of captured 2D images forms a stack of 2D images; and | at a different focus plane position such that the series of captured 2D images forms a stack of 2D images; and |
| [1.4.a]: a data processing system configured to derive surface geometry information for a block of said image sensor pixels from the 2D images in the stack of 2D images captured by said color image sensor, [1.4.b] the data processing system also configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information; | [29.4.a]: a data processing system configured to derive surface geometry information for a block of said image sensor pixels from the 2D images in the stack of 2D images captured by said color image sensor, [29.4.b] the data processing system also configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information, and | [31.4.a]: a data processing system configured to derive surface geometry information for a block of said image sensor pixels from the 2D images in the stack of 2D images captured by said color image sensor, [31.4.b] the data processing system also configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information, | [32.4.a]: a data processing system configured to derive surface geometry information for a block of said image sensor pixels from the 2D images in the stack of 2D images captured by said color image sensor, [32.4.b] the data processing system also configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information; | [34.4.a]: a data processing system configured to derive surface geometry information for a block of said image sensor pixels from the 2D images in the stack of 2D images captured by said color image sensor, [34.4.b] the data processing system also configured to derive surface color information for the block of said image sensor pixels from at least one of the 2D images used to derive the surface geometry information, |

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| <u>Claim 1</u> ¹⁰ | <u>Claim 29</u> | <u>Claim 31</u> | <u>Claim 32</u> | <u>Claim 34</u> |
|--|------------------------|------------------------|------------------------|------------------------|
| <p>[1.5.a]: wherein the data processing system further is configured to combining a number of sub-scans to generate a digital 3D representation of the object, and</p> <p>[1.5.b] determining object color of a least one point of the generated digital 3D representation of the object from sub-scan color of the sub-scans combined to generate the digital 3D representation, such that the digital 3D representation expresses both geometry and color profile of the object, and</p> | | | | |
| <p>[1.6]: wherein determining the object color</p> | | | | |

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| <u>Claim 1</u> ¹⁰ | <u>Claim 29</u> | <u>Claim 31</u> | <u>Claim 32</u> | <u>Claim 34</u> |
|--|--|--|------------------------|------------------------|
| comprises computing a weighted average of sub-scan color values derived for corresponding points in overlapping sub-scans at that point of the object surface. | | | | |
| | [29.5]: where the data processing system further is configured to detecting saturated pixels in the captured 2D images and for mitigating or removing the error in the derived surface color information or the sub-scan color caused by the pixel saturation. | | | |
| | | [31.5.a]: where the data processing system further is configured to derive the surface geometry information is derived from light in | | |

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| <u>Claim 1</u> ¹⁰ | <u>Claim 29</u> | <u>Claim 31</u> | <u>Claim 32</u> | <u>Claim 34</u> |
|------------------------------|-----------------|--|---|--------------------------------------|
| | | a selected wavelength range of the spectrum provided by the multichromatic light source, and | | |
| | | [31.5.b]: where the color filter array is such that its proportion of pixels with color filters that match the selected wavelength range of the spectrum is larger than 50%. | | |
| | | | [32.5.b]: the filters are arranged in a plurality of cells of 6x6 color filters, where the color filters in positions (2,2) and (5,5) of each cell are of the W1 type, the color filters in positions (2,5) and (5,2) are of the W3 type. | |
| | | | | [34.4.c]: where deriving the surface |

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| <u>Claim 1</u> ¹⁰ | <u>Claim 29</u> | <u>Claim 31</u> | <u>Claim 32</u> | <u>Claim 34</u> |
|------------------------------|-----------------|-----------------|-----------------|---|
| | | | | geometry information and surface color information comprises calculating for several 2D images a correlation measure between the portion of the 2D image captured by said block of image sensor pixels and a weight function, where the weight function is determined based on information of the configuration of the spatial pattern, and |
| | | | | [34.4.d]: identifying the position along the optical axis at which the corresponding correlation measure has a maximum value, |
| | | | | [34.4.e]: where the data processing system further is configured for |

Second Corrected Petition for PGR2018-00103
U.S. Patent No. 9,962,244

| <u>Claim 1</u> ¹⁰ | <u>Claim 29</u> | <u>Claim 31</u> | <u>Claim 32</u> | <u>Claim 34</u> |
|-------------------------------------|------------------------|------------------------|------------------------|---|
| | | | | determining a sub-scan color for a point on a generated sub-scan based on the surface color information of the 2D image in the series in which the correlation measure has its maximum value for the corresponding block of image sensor pixels and |
| | | | | [34.4.f]: computing an averaged sub-scan color for a number of points of the sub-scan, where the computing comprises an averaging of sub-scan colors of surrounding points on the sub-scan. |