

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ALIGN TECHNOLOGY, INC.,
Petitioner,

v.

3SHAPE A/S,
Patent Owner.

IPR2020-01087
Patent 10,349,042 B1

Before FRANCES L. IPPOLITO, NORMAN H. BEAMER, and
JASON M. REPKO, *Administrative Patent Judges*.

REPKO, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Align Technology, Inc. (“Petitioner”) filed a petition to institute *inter partes* review of claims 1–22 of U.S. Patent No. 10,349,042 B1 (Ex. 1001, “the ’042 patent”). Paper 3 (“Pet.”). 3Shape A/S (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). Under our authorization (Paper 8), Petitioner filed a Reply to Patent Owner’s Preliminary Response (Paper 10), and Patent Owner filed a Sur-Reply (Paper 11).

On January 20, 2021, we instituted an *inter partes* review of all challenged claims based on all grounds in the Petition. Paper 15 (“Inst. Dec.”). Patent Owner filed a Response. Paper 20 (“PO Resp.”). Petitioner filed a Reply. Paper 26 (“Pet. Reply”). Patent Owner filed a Sur-reply. Paper 32 (“Sur-reply”). An oral hearing was held on October 22, 2021. A transcript of that hearing has been entered into the record. Paper 37 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued under 35 U.S.C. § 318(a). For the reasons that follow, Petitioner has shown by a preponderance of the evidence that claims 1–22 are unpatentable.

A. Related Matters

According to the parties, the ’042 patent has been asserted in *3Shape A/S v. Align Technology, Inc.*, No. 1:18-cv-00886 (D. Del.). Pet. 14; Paper 4, 1 (Mandatory Notices). Also, Petitioner filed two other petitions requesting *inter partes* review of the ’042 patent: IPR2020-01088 and IPR2020-01089. Pet. 14; Paper 4, 1. The Board denied institution of the petitions in IPR2020-01088 and IPR2020-01089. *Align Tech. v. 3Shape A/S*, IPR2020-01088, Paper 14 (PTAB Jan. 20, 2021).

B. The '042 Patent

The '042 patent generally relates to optical three-dimensional (“3D”) surface scanning. Ex. 1001, 1:20–21. One embodiment performs intraoral scanning: direct scanning of teeth and surrounding soft tissue. *Id.* at 1:23–26. The scanner uses out-of-focus information to determine the 3D structure of teeth. *See id.* at 2:36–38, 27:35–37.

In particular, the scanner generates a pattern on the object. *Id.* at 27:16. The scanner adjusts its focus so that the image of the pattern on the scanned object is shifted along the optical axis. *Id.* at 27:48–51. When the pattern is varied over time and the focus is fixed, the in-focus regions will display a spatially varying pattern, and the out-of-focus regions will display little to no contrast. *Id.* at 27:51–55. The focus position is moved in steps from one end of the scanning region to the other. *Id.* at 27:61–62. The scanner determines the object’s 3D structure by correlating the data collected at a range of different focus positions. *Id.* at 27:55–62.

C. Claims

Claims 1, 17, 19, and 21 are independent. Claim 17 is reproduced below with line breaks added.

17. An intraoral scanner for providing data for 3D geometry of at least a part of the surface of an object in an oral cavity, the intraoral scanner comprising:

a color image sensor comprising an array of sensor elements;

lighting equipment configured to generate a probe light; and

an optical system comprising a beam splitter, at least one lens, and a tip configured to be inserted into the oral cavity,

wherein the intraoral scanner is configured to operate by translating a focus plane along an optical axis of the optical system to capture one or more 2D images,

wherein the at least one lens is configured such that the intraoral scanner transmits at least a part of the probe light from the lighting equipment through the optical system and towards the object such that the at least a part of the probe light is non-telecentrically focused on at least a part of the surface of the object,

wherein reflected light results from the at least a part of the probe light being reflected from the at least a part of the surface of the object, and

wherein the intraoral scanner is further configured to transmit the reflected light from the at least a part of the surface of the object back through the optical system such that the reflected light is focused on the color image sensor,

the color image sensor being configured to produce the data for the 3D geometry from a series of 2D images captured by the intraoral scanner translating the focus plane along the optical axis of the optical system,

at least one of the series of 2D images being generated using the reflected light focused on the color image sensor.

Ex. 1001, 38:43–39:2.

D. Evidence

Name	Reference	Exhibit No.
Morgan	US 5,381,236 A, issued Jan. 10, 1995	1011
Noguchi	JP 3321866, issued June 28, 2002	1012, 1013 ¹
Geng	US 7,099,732 B2, issued Aug. 29, 2006	1014
Bayer	US 3,971,065, issued July 20, 1976	1016
Engelhardt	US 6,263,234 B1, issued July 17, 2001	1045

¹ Exhibit 1012 is the original Japanese patent document. Exhibit 1013 is a certified English translation of Exhibit 1012. With our authorization, Petitioner filed a corrected version of Exhibit 1012, replacing an originally filed version, which inadvertently contained a copy of JP H6-201336 instead of JP 3321866. Ex. 3001.

E. Instituted Grounds

Claims Challenged	Pre-AIA² 35 U.S.C. §	Reference(s)/Basis
1–3, 6–8, 10, 13–22	103(a)	Morgan, Geng
4, 5, 9	103(a)	Morgan, Geng, Bayer
11, 12	103(a)	Morgan, Geng, Engelhardt
1–3, 6–8, 10, 13–22	103(a)	Noguchi
4, 5, 9	103(a)	Noguchi, Bayer
11, 12	103(a)	Noguchi, Engelhardt

II. ANALYSIS

A. Level of Ordinary Skill in the Art

According to Petitioner,

One of ordinary skill prior to June 17, 2009, would include someone who had (1) at least a bachelor’s degree in optics, electrical engineering, optical engineering, physics or an equivalent field, as well as at least one or two years of industry experience in optical scanning; (2) at least five years of comparable experience in optical scanning; or (3) an equivalent combination of academic study and work experience.

Pet. 13 (citing Hesselink Decl.³ ¶¶ 48–50).

In its Response, Patent Owner also applies this skill level. PO Resp. 3 (citing Pet. 3; Ex. 1002 ¶¶ 48–50; Sergienko Decl. ¶ 23).⁴

For the purpose of this decision, we apply Petitioner’s proposed definition, which appears to be consistent with the level of skill reflected in the asserted references. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355

² Congress amended § 103 when it passed the Leahy-Smith America Invents Act (AIA). Pub. L. No. 112–29, § 3(c), 125 Stat. 284, 287 (2011). Here, Petitioner asserts that the previous version of § 103 applies. Pet. 11–12, 15. We agree.

³ The declaration of Lambertus Hesselink, Ph.D. (“Hesselink Decl.”) is Exhibit 1002.

⁴ The declaration of Alexander Sergienko, Ph.D. (“Sergienko Decl.”) is Exhibit 2019.

(Fed. Cir. 2001) (explaining that the prior art itself can reflect an appropriate level of skill in the art).

B. Claim Construction

Petitioner proposes a construction for (1) “focus plane”: “[a] surface where light rays emitted from [a] pattern converge to form an image on [an] object being scanned[;] [t]he focus plane does not need to be flat [and] may be a curved surface” and (2) “pattern”: “[a] light signal comprising an embedded spatial structure in the lateral plane.” Pet. 19. Petitioner asserts that “the term ‘non-telecentric’ denotes the nonparallel travel of chief rays through a lens system, resulting in magnification changes across focus-plane positions.” *Id.* at 21.

We need only construe terms that are in controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). Here, no terms are in controversy. Patent Owner explains that, in the related litigation, the District Court issued a Memorandum Order (Ex. 2022) adopting the Report and Recommendation on Claim Construction (Ex. 2021).

In the related litigation, the District Court construed (1) “optical system” as “an arrangement of optical components, e.g., lenses, that transmit, collimate and/or images light, e.g., transmitting probe light towards the object, imaging the pattern on and/or in the object, and imaging the object, or at least a part of the object, on the camera”; (2) “focus plane” as “[a] surface where light rays emitted from the pattern converge to form an image on the object being scanned. The focus plane does not need to be flat. It may be a curved surface.”; and (3) the antecedent of “the at least a part of the probe light” as “at least a part of the probe light from the lighting

equipment through the optical system and towards the object.” Ex. 2021, 3–4.

According to Patent Owner, Petitioner does not show unpatentability under the constructions proposed in the Petition. PO Resp. 3–4 (citing Pet. 19–21). Patent Owner, though, does not contest Petitioner’s constructions in this proceeding. *See id.*

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and claim-construction analysis. *See* Pet. 19–21. So we adopt Petitioner’s proposed constructions here. *See id.* We note that Petitioner applies the District Court’s construction of “focus plane” in the Petition. *Compare* Ex. 2021, 3, *with* Pet. 19; *see also* PO Resp. 35.

The additional terms construed in the related litigation are not relevant to the resolution of the arguments and issues raised in this proceeding. *See* Ex. 2021, 3–4. In particular, Patent Owner argues that Petitioner has not shown unpatentability under the additional constructions made by the District Court. PO Resp. 3–4. But Patent Owner does not present specific arguments directed to the Morgan-Geng combination that are based on the District Court’s construction of “optical system” or “the at least a part of the probe light.” PO Resp.; Sur-reply. Even so, as discussed below, Petitioner shows that the Morgan-Geng combination teaches or suggests the “optical system” and “the at least a part of the probe light” even under the District Court’s construction. *See supra* §§ C.3.d), f).

Also, Patent Owner notes that, “[i]n the related litigation, Petitioner and Patent Owner agreed that the preambles of the independent claims are limiting, and the District Court adopted this construction.” PO Resp. 4 (citing Ex. 2021, 1–2). We agree that the preambles are limiting for the reasons discussed in detail in Section II.C.3.a).

As for dependent claim 6, Petitioner argued in the related litigation that “the un rebutted declaration from Professor Smith from RIT is that a person of ordinary skill wouldn’t recognize ‘image measure’ as a term of art and it would just be, if anything, something that refers to ‘correlation measure.’” Ex. 1023, 64:19–23. According to the adopted Report and Recommendation on Claim Construction,

[T]he record before the Court contains, on one side, an expert declaration opining that a person of skill in the art would not understand the scope of the term “image measure” and, on the other side, conclusory attorney argument that the term “image measure” is clear but no articulation as to what that clear meaning is.

Under these circumstances, I believe that Align has met its burden to show by clear and convincing evidence that “image measure” is indefinite.

Ex. 2021, 23–24.

For the prior-art challenge in the Petition, Petitioner treats the term “image measure” as “not necessarily limited to the correlation measure described in the ’042 patent’s specification and instead includes any measure of the image (e.g., light intensity).” Pet. 20. Patent Owner did not rebut this assertion. *See* PO Resp.; Sur-reply.

We need not address indefiniteness here. Indeed, the Federal Circuit has stated that indefiniteness “does not necessarily preclude the Board from addressing the patentability of the claims on section 102 and 103 grounds.” *Samsung Elecs. Am., Inc. v. Prisia Eng’g Corp.*, 948 F.3d 1342, 1353 (Fed. Cir. 2020). For the purposes of determining the patentability of dependent claim 6, we apply Petitioner’s construction, which is un rebutted. *See* Pet. 20.

C. Obviousness over Morgan and Geng

Petitioner asserts that claims 1–3, 6–8, 10, and 13–22 are obvious over Morgan and Geng. Pet. 20–50.

1. Morgan

Morgan describes an optical sensor for imaging an object. Ex. 1011, (54). The sensor adjusts its lens system to focus on successive planes covering the object. *Id.* at 8:13–17. The resulting data is used to build a 3D range map of the object. *Id.* According to Morgan, conventional systems are restricted to edge or textured features. *Id.* at 8:26–30. Unlike those systems, Morgan’s system projects a pattern onto the object being viewed. *Id.* As a result, the sensor is able to sense plain, un-textured surfaces, such as painted walls, floors, skin, among other things. *Id.* The projected pattern can then be easily analyzed to determine which parts are in focus. *Id.* at 8:30–35.

2. Geng

Geng describes an intraoral imaging system that creates a 3D image and 2D color images of dental structures. Ex. 1014, 3:53–54. The data produced by Geng’s system can be used to manufacture a dental part or an orthodontic device. *Id.* at 5:30–34. The color images are used to provide shading, color, and shadows. *Id.* at 4:21–25. Geng explains that correct color shading may be important to the patient and the dentist. *Id.* at 4:26–27.

3. Independent Claim 17

Petitioner asserts that the Morgan-Geng combination teaches or suggests each limitation of claim 17. Pet. 22–32.

a) Preamble and “tip configured to be inserted into the oral cavity”

Claim 17’s preamble recites, “An intraoral scanner for providing data for 3D geometry of at least a part of the surface of an object in an oral cavity.” Ex. 1001, 37:19–21. According to Patent Owner, the preamble is

limiting because it provides antecedent support for terms recited in the body. PO Resp. 4. Petitioner does not dispute this. *See* Pet.

We agree that the preamble is limiting. “If the claim preamble, when read in the context of the entire claim, recites limitations of the claim, or, if the claim preamble is ‘necessary to give life, meaning, and vitality’ to the claim, then the claim preamble should be construed as if in the balance of the claim.” *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1305 (Fed. Cir. 1999). Here, the body of the claim recites, in part, “an optical system comprising a beam splitter, at least one lens, and a tip configured to be inserted into *the oral cavity*.” Ex. 1001, 38:47–49 (emphasis added). In this limitation, the term “oral cavity” gives meaning to the tip’s structure because the term defines the tip’s configuration by reciting how the tip is used. And the antecedent basis for “the oral cavity” is found in the preamble. In at least this way, the preamble gives meaning to the terms recited in the body and limits the structure of the claimed invention.

Petitioner asserts that the combination of Morgan and Geng teaches or suggests the preamble and the tip configured to be inserted into the oral cavity. Pet. 22–23. In particular, Petitioner asserts that Morgan teaches a confocal optical sensor and suggests using the sensor for mapping dental cavities. *Id.* (citing Ex. 1011, 16:7–20). But, according to Petitioner, “Morgan does not expressly disclose an intraoral scanner having a tip configured to be inserted into the oral cavity.” *Id.* at 48.

For this disclosure, Petitioner turns to Geng’s teachings about tip shapes for intraoral probes. *Id.* Petitioner asserts that one of ordinary skill in the art would have understood that, “to map dental cavities as suggested by Morgan, the most practicable configuration would include adapting the

scanner to be introduced within the oral cavity (i.e., an intraoral scanner).” *Id.* (citing Hesselink Decl. ¶ 86).

Patent Owner argues that “it would not have been obvious to incorporate Morgan’s variable focal length lens embodiment on board an intraoral probe in view of Geng.” PO Resp. 14 (citing Sergienko Decl. ¶ 46); *see also* Sur-reply 12–13. In Patent Owner’s view, there is no reasonable expectation of success for doing so considering the embodiment’s mechanical complexity. PO Resp. 15–17. Patent Owner also argues that Morgan’s variable focal length lens embodiment is not shown to be applicable to intraoral scanning and has “serious problems.” *Id.* at 17–20. That is, Patent Owner’s arguments are directed to a specific embodiment in Morgan: the variable focal length lens. *See id.* at 13–21; Sur-reply 10–13.

We disagree with these arguments because Morgan teaches that a variable focal length lens is only one option among several. *See* Ex. 1011, 14:14–55. Morgan’s lens system focuses on successive planes covering the object. *Id.* at 8:13–17. Morgan explains that the lens system “may simply comprise a fast, high quality camera lens,” which could be “relatively inexpensive.” *Id.* at 14:14–16. Morgan teaches that, alternatively, a variable focus lens system such as a zoom lens could be used. *Id.* at 14:17–55. Morgan also teaches that one may use a single-element large-aperture aspheric lens, a mirror lens, or a flexible liquid-filled lens. *See id.*

Petitioner’s obviousness rationale does not depend on any particular embodiment in Morgan. *See, e.g.,* Pet. 27. For example, to address the

limitation about focusing light,⁵ Petitioner discusses the normal-lens and zoom-lens embodiments:

Morgan teaches a scanner having a lens arrangement that non-telecentrically focuses the probe light onto the object because it discusses addressing characteristics associated with “a normal lens system,” such as “magnification changes during the sweep of the lens,” and uses a “variable focal length lens system such as a zoom lens” to compensate for those changes.

Pet. 27 (citing Ex. 1011, 14:34–50). We disagree with Patent Owner that, here, Petitioner relies on Morgan’s variable focal length lens embodiment to address a problem in non-telecentric systems. PO Resp. 13. Instead, Petitioner cites this passage from Morgan to show that it teaches a non-telecentric system. *See* Pet. 27 (citing Ex. 1011, 14:34–50). In other words, Petitioner asserts that Morgan teaches a non-telecentric system “because it discusses addressing” the characteristics of a normal lens system. *See id.*; *see also* Pet. Reply 4–5.

We disagree with Patent Owner’s arguments directed to particular features of the variable focal length lens embodiment. *See* PO Resp. 14–19; Sur-reply 10–13. For example, Patent Owner faults the Petition for not explaining where Morgan’s lens system would have been positioned in Geng’s device. PO Resp. 14. Patent Owner argues that Morgan’s variable focal length lens system must be located on board the probe to correct for the magnification changes. *Id.* at 14–15; *see also* Sur-reply 10–12. In Patent Owner’s view, Geng teaches that it is critical for the fiber-optic bundle’s output end to be positioned in a fixed relationship with the CCD’s receiving end. PO Resp. 15 (citing Ex. 1014, 4:5–12). But these arguments are based

⁵ We fully analyze the limitation about focusing light in Section II.C.3.f) *infra*.

on technical features that are not relevant to Petitioner’s rationale—e.g., correcting for magnification changes and Geng’s fiber optics. *See id.* at 14–19; Sur-reply 12. For this reason, we disagree with Patent Owner’s argument (*id.*) and assign little weight to the Sergienko Declaration on this issue. *See* Sergienko Decl. ¶¶ 46–51.

We see no evidence that Petitioner’s obviousness rationale about the preamble and tip requires correcting for the magnification changes. *See* PO Resp. 14–15; Sur-reply 10–12. In fact, according to Morgan, each embodiment has advantages and disadvantages: An advantage of a normal lens is that it is “relatively inexpensive.” Ex. 1011, 14:14–16. A disadvantage of using a normal lens is that its magnification changes during the sweep of the lens. *Id.* at 14:34–37. But Morgan does not require resolving the magnification-change issue. *See id.* at 14:14–46. On the other hand, a zoom lens has the advantage of maintaining a constant net magnification by changing the focal length during the sweep. *Id.* at 14:42–46. One disadvantage of a zoom lens is its limited depth resolution. *Id.* at 14:23–25.

The challenged claim does not require a zoom lens or a normal lens. Rather, the claim functionally defines the lens system’s configuration based on how it transmits light. To address those limitations, Petitioner relies on Morgan’s lens system to perform the focus sweep. *See* Ex. 1011, 8:13–17, 14:14–55. And, as discussed below, we agree with Petitioner’s analysis of those other limitations. *See infra* §§ II.C.3.b)–i) (analyzing Petitioner’s showing in detail).

Even assuming that the proposed combination requires a variable focal length lens system, the test for obviousness does not ask whether Morgan’s lens system could be incorporated in Geng’s probe without further

modification. *See In re Keller*, 642 F.2d 413, 425 (CCPA 1981). For this additional reason, we disagree with Patent Owner's arguments based on bodily incorporation of Morgan's optics on board Geng's probe, and assign little weight to the Sergienko Declaration on this issue. *See* PO Resp. 14–17; Sergienko Decl. ¶¶ 46–51.

Here, Petitioner is merely proposing to use Geng's probe tip in Morgan's scanning system. Pet. 22. Geng's probe tip does not include the technical features that are the basis for Patent Owner's argument about mechanical complexity and lens positioning. *See* PO Resp. 14–17. In particular, Geng teaches that probe 105 is inserted in a patient's mouth. Ex. 1014, 5:58–61. Geng teaches that sanitary sleeve 300 is “disposed around” the end of probe 105. *Id.* Geng's Figure 3, below, shows that the components that Patent Owner discusses are external to the part that is inserted in the patient's mouth and covered by sanitary sleeve 300. *Id.*, Fig. 3.

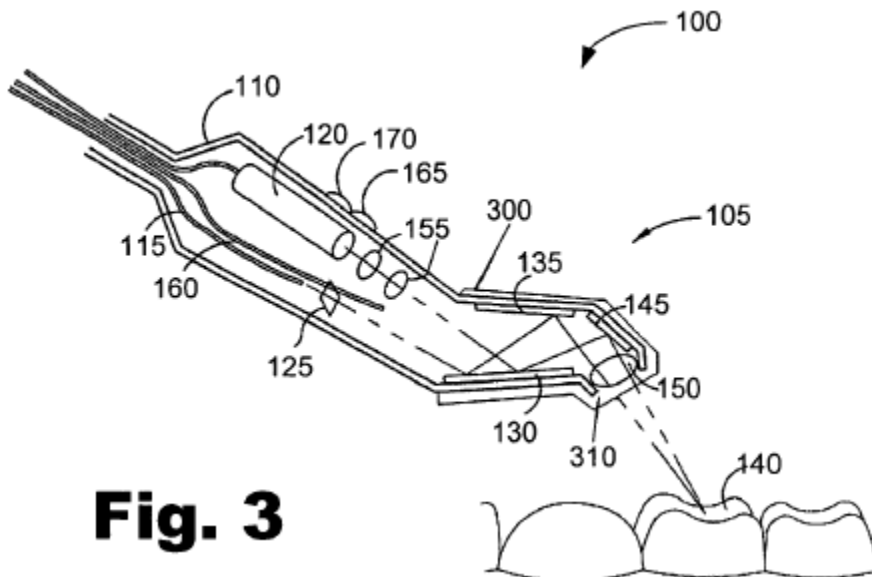


Figure 3, above, shows that the part of the probe covered by sanitary sleeve 300, i.e., the tip, does not include CCD 120 and fiber optics 115. *Id.*

Petitioner's obviousness rationale merely proposes using Geng's tip in Morgan. *Id.*; Pet. 22. For at least this reason, Patent Owner's argument that adding Morgan's components would make Geng's optics more complex does not squarely address Petitioner's rationale about the tip. *See* PO Resp. 14–17.

Petitioner's obviousness rationale is bolstered by Morgan's teachings about scanning intraoral surfaces. *See* Pet. 22. For example, Morgan teaches that the sensors can map “dental cavities for automatic machining of ceramic filling inserts.” Ex. 1011, 16:7–16, *cited in* Pet. 22. Petitioner asserts that a person of ordinary skill in the art “would have sought to configure the scanner as an ‘intraoral’ device for insertion into a patient's oral cavity” to map dental cavities using a scanner like Morgan's. Pet. 23 (citing Hesselink Decl. ¶ 97).

Dr. Hesselink explains that “the most practicable configuration” for the oral scanner would be one that allows the scanner to be inserted in the oral cavity. Hesselink Decl. ¶ 86, *cited in* Pet. 22. According to Dr. Hesselink, the tip “would be sized to be inserted into the oral cavity in order to emit a probe light onto the object's surface (e.g., cavity surface) for proper imaging.” *Id.*

Patent Owner argues that Morgan “lists dentistry as one possible application but has no mention of intraoral scanning.” PO Resp. 19 (citing Ex. 1011, 16:7–20, 23–25). Patent Owner disagrees that the “most practicable configuration” would be to adapt Morgan's scanner. *Id.* at 21 (citing Pet. 48). According to Patent Owner, “other options were available for mapping dental cavities that do not involve a tip configured to be inserted into the oral cavity such as scanning an impression model of teeth (e.g., plaster cast) but Dr. Hesselink” does not compare his proposed

modification to any alternatives. *Id.* (citing Ex. 2025, 1:54–2:1, 9:10–15, Fig.10; Ex. 2026, 1:45–56; Sergienko Decl. ¶ 53).

We disagree with Patent Owner’s argument (*id.*) and assign the Sergienko Declaration little weight on this issue (Sergienko Decl. ¶¶ 50, 53) because “[t]he question in an obviousness inquiry is . . . not whether each individual reference discloses all of the necessary elements.” *Game & Tech Co. v. Wargaming Grp. Ltd.*, 942 F.3d 1343, 1352 (Fed. Cir. 2019). Here, Morgan need not expressly disclose intraoral scanning involving inserting the probe in a patient’s mouth. Rather, Morgan’s teachings about oral scanning combined with Geng’s teaching of a specific tip for performing that type of scanning is sufficient to support Petitioner’s assertions and Dr. Hesselink’s testimony about the obviousness of the combination. *See* Pet. 25; Hesselink Decl. ¶ 86.

Morgan not only teaches that dentistry is one possible application but also that the scanner “is easier to apply” at small scales. Ex. 1011, 8:47–63, *cited in* Pet. Reply 6. According to Dr. Sergienko’s testimony, “The design requirements for intraoral scanners are very clearly put forward in the Morgan patent.” Ex. 1056, 25:3–5.

Although Patent Owner mischaracterizes the obviousness rationale as requiring a zoom lens, Petitioner and Dr. Hesselink provide supporting examples of zoom lenses in intraoral handheld devices. Pet. Reply 7 (citing Ex. 1058, Abstract, 3:45–59, 4:60–67, 6:39–45, Figs. 1, 2 (“a zoom lens adapter for endoscopic camera of ‘about 1.5 inches in length’”); Ex. 1059, Abstract, 2:46–53, 8:34–38, Fig. 7 (“intraoral camera incorporating zoom lenses”); Ex. 1066, 1:6–8, 1:30–2:18 (“zoom lens for mobile phone”)). This additional evidence persuasively responds to and rebuts Patent Owner’s arguments about the lack of an expectation of success of using zoom lenses

for intraoral scanning. *See* PO Resp. 15–17 (discussing Watanabe (Ex. 1018) and Willson (Ex. 2027)).

Even so, the evidence filed with the Petition adequately supports the Hesselink Declaration and Petitioner’s assertions about the obviousness of adding a tip to Morgan. *See, e.g.*, Pet. 25, 48. Specifically, Geng’s Figure 3 shows a tip shaped for insertion in the patient’s mouth. Ex. 1014, Fig. 3. In describing the shape, Geng explains that the tip has an “appropriately shaped housing” for intraoral imaging. *Id.* at 3:55–56, *cited in* Pet. 25.⁶ Geng describes how the tip images dental structures. *Id.* at 6:15–34 (describing how the tip is used), *cited in* Pet. 25. Considering these passages, we credit the Hesselink Declaration on the issue of the obviousness of adding Geng’s tip to Morgan. Hesselink Decl. ¶ 86.

For the reasons discussed, we determine that Petitioner provides articulated reasoning, supported by rational underpinnings, why one of ordinary skill in the art would have combined Geng’s tip and Morgan’s sensor. *See KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). Based on Petitioner’s analysis, we find that a person of ordinary skill in the art would have modified Morgan with Geng to obtain an intraoral scanner, as recited in the preamble and in the tip limitation.

⁶ Because Geng’s teachings sufficiently support Dr. Hesselink on this issue, we need not review the two additional references. In particular, Petitioner comments that, “by June 17, 2009, confocal scanners used intraorally were well-known and conventionally included a tip for insertion into the oral cavity.” Pet. 48 (citing Hesselink Decl. ¶ 86); Exs. 1010, 1017; PO Resp. 21–22 (discussing Exs. 1010, 1017). This assertion is cumulative to Petitioner’s obviousness rationale based on Geng, which is sufficiently supported. *See* Pet. 48.

b) Color Image Sensor

Claim 17 recites, in part, “a color image sensor comprising an array of sensor elements.” Ex. 1001, 38:45–46. Claim 17 further recites, in part, “the color image sensor being configured to produce the data for the 3D geometry from a series of 2D images captured by the intraoral scanner translating the focus plane along the optical axis of the optical system.” *Id.* at 38:64–67.

(1) Petitioner’s Obviousness Rationale

Petitioner asserts that Morgan teaches a confocal optical sensor that includes detector 1, which has a CCD array Pet. 23 (citing Ex. 1011, Abstract, 1:55–60, 3:21–44, 4:35–42, 10:33–34, Figs. 1–2). Petitioner, though, asserts that Morgan lacks the recited color image sensor. *Id.* at 48; *see also id.* at 23–24 (citing Hesselink Decl. ¶ 103).

For the color image sensor, Petitioner turns to Geng. *Id.* at 24, 32. Petitioner has sufficiently shown that Geng teaches this feature: Geng teaches that intra-oral imaging system 100 produces both 3D and color 2D images of a dental structure. Ex. 1014, 3:53–58, *cited in* Pet. 24. To create those images, Geng’s system uses CCD 120. *See id.* at 3:53–58, 4:25–26, 5:30–34, *cited in* Pet. 24.

As for the reason to combine Geng with Morgan, Petitioner asserts that Geng’s CCD obtains “intra-oral images with accurate color representation for shading, color shadings and shadows,” and “allows for dental appliances having a more ‘natural’ effect.” Pet. 48–49 (citing Ex. 1014, 3:53–58, 4:21–35). According to Petitioner, those dental appliances would include Morgan’s ceramic-filling inserts. *Id.* at 49 (citing Ex. 1011, 16:7–20; Hesselink Decl. ¶¶ 87–90).

(2) *Morgan's Filter*

Patent Owner argues that Petitioner's combination requires a limited bandwidth filter, which would not permit color scanning. *See* PO Resp. 5–11. In Patent Owner's view, "Morgan explicitly teaches use of the limited bandwidth filter to 'match the light source' when the limited bandwidth light source is used." *Id.* at 6 (Ex. 1011, 14:8–13).

We agree that Morgan teaches using a limited bandwidth light filter with a limited bandwidth light source. *See id.* But the cited passage from Morgan indicates that using a filter is not the only way to improve resolution:

One way to improve resolution is to restrict the spectral bandwidth (to minimize chromatic aberration) with filters or by choice of light source e.g. laser diodes. A filter would then be used in front of the detector 1 to match the light source in order to cut out unwanted background light.

Ex. 1011, 14:8–13 (emphasis added), *cited in* PO Resp. 6.

That is, the passage does not indicate that Morgan's filter is required—only that the filter is "one way" of improving performance in this scenario. *Id.*

In Patent Owner's view, Morgan expressly teaches removing unwanted background light. PO Resp. 8–9 (citing Ex. 1011, 14:11–13; Ex.2012, 3:65–4:3; Sergienko Decl. ¶ 40). Patent Owner argues that, in view of this express teaching, "even if Petitioner had alleged removing Morgan's limited bandwidth filter to allow for color scanning in its theory—which it did not—such a modification would not have been obvious." *Id.* But Patent Owner's argument is contradicted by Morgan's passage that the filter is only "one way" to improve resolution. *See* Ex. 1011, 14:8–13. Thus, we disagree with Patent Owner's argument and assign the Sergienko Declaration little weight on this issue. *See* PO Resp. 8–9; Sergienko Decl. ¶ 40.

In fact, the claim does not recite a limited bandwidth filter, and the Petition does not map Morgan’s filter to any particular recited feature. *See* Pet; *accord* PO Resp. 8 (“The Petition is silent concerning Morgan’s limited bandwidth filter.”). Because Morgan’s filter is only “one way” of improving performance, Morgan does not indicate that Petitioner’s combination requires the filter to meet any of the limitations. *See* Ex. 1011, 14:8–13. For at least this reason, we disagree with Patent Owner’s argument about the color filter. *See* PO Resp. 5–11.

Also, “[a] person of ordinary skill in the art is also a person of ordinary creativity, not an automaton.” *KSR*, 550 U.S. at 421. One must account for “the inferences and creative steps that a person of ordinary skill in the art would employ.” *Id.* at 418. We disagree with Patent Owner’s arguments about the color filter for the additional reason that the arguments do not account for these inferences and steps. *See* PO Resp. 5–11.

Specifically, Morgan’s filter removes unwanted background light by matching the light source. Ex. 1011, 14:8–13. Patent Owner argues that Morgan’s filter would only allow light at the frequency emitted by its limited bandwidth light source, not the full range required for color imaging. PO Resp. 7. But the Hesselink Declaration explains that, when color imaging is desired, white light illuminates the object being scanned and the reflected light is filtered by the color filters. *See* Hesselink Decl. ¶ 69 (citing Ex. 1041, 201; Ex. 1013, ¶¶ 43–45; Fig. 16). In one cited example, “[e]ach image sensor is covered with its own color filter . . . , and together the three image sensors acquire the complete colorimetric information about a scene.” Ex. 1041, 201. The Hesselink Declaration describes other ways to perform color imaging. *See, e.g.*, Hesselink Decl. ¶¶ 69–70 (citing Ex. 1010 ¶¶ 143, 147 (rotating RGB filters); Ex. 1016 Abstract, 2:45–57, Fig. 6 (describing

Bayer filter arrays); Ex. 1028 ¶¶ 23, 67, Fig. 2; Ex. 1027, 2:56–64, 15:30–43; Ex. 1041, 200–203, 7.20). The cited evidence shows that using a filter, as suggested in one embodiment of Morgan, would not have been incompatible with color image sensing. *See id.* Because the Hesselink Declaration is consistent with the cited teachings, we credit Dr. Hesselink on this issue. *See id.*

Similarly, in response to Patent Owner’s arguments about the color filter, Petitioner argues that color imaging typically involves limited bandwidth filters. Pet. Reply 2. Petitioner asserts that a person of ordinary skill in the art would “select a light source matched to a particular filter (e.g., red, green, or blue) for 3D imaging, and, using the second light source, the methods would allow for 2D color imaging.” *Id.* at 3. Petitioner’s Reply points to a Bayer filter, a Foveon sensor, a three-chip CCD, and a retractable/rotatable filter. *Id.* at 2–3.

We disagree with Patent Owner’s characterization of Petitioner’s reply arguments about color filters as “new theories.” Sur-reply 5–10. In each case, Petitioner is not proposing to use another color imaging device in place of Geng’s. *Id.* at 5–6. Rather, Petitioner fairly responds to Patent Owner’s assertions about filtering by showing that “[e]ven if the proposed combination did require a limited bandwidth filter, it would be compatible with color imaging.” Pet. Reply 2. So we need not assess whether each type of filter cited by Petitioner was suitable for 3D scanning, as Patent Owner has. *See* Sur-reply 6–10. By relying on these embodiments, which were presented in Dr. Hesselink’s original Declaration, Petitioner fairly and persuasively rebuts Patent Owner’s argument about filtering and color imaging. *See* Pet. Reply 2–3.

To establish obviousness, Petitioner need not show that a color image sensor could be bodily incorporated into Morgan without modifying other components, such as the optional filter. *See Keller*, 642 F.2d at 425. So we disagree that Petitioner needed to explain in the Petition how Morgan's limited bandwidth filter works with Geng's color image sensor to obtain accurate color representation. PO Resp. 7–8.

(3) Two Sensors

Also, Petitioner did not state that the proposed combination would use two sensors: one for 2D color and another for 3D data. *See* Pet; PO Resp. 12–13. Rather, the Petition explains that “*Morgan teaches an image sensor that produces the data for the 3D geometry from a series of 2D images captured by the scanner translating the focus plane along the optical axis,*” and a person of ordinary skill in the art would have “*made the sensor a color image sensor.*” Pet. 31–32 (emphasis added). Here, the phrase “made the sensor” refers to Morgan's single sensor. *See id.* So we do not address Patent Owner's arguments about a two-sensor system. *See* PO Resp. 12–13.

(4) Misregistration

Patent Owner argues that one could not have reasonably expected to successfully add a color scanner to Morgan's scanner because chromatic aberration would cause significant misregistration. PO Resp. 20 (citing Ex. 2021, Abstract). To support its argument, Patent Owner cites Willson. *Id.* (citing Ex. 2027). According to Patent Owner, Willson addresses the misregistration problem by using a “stationary, large-scale system.” *Id.* Patent Owner faults Petitioner for not addressing the alleged problem of “significant misregistration.” *Id.* at 20–21.

According to Willson, “Vision researchers base their work on assumptions that lenses behave ideally.” Ex. 2027, Abstract. The explanation

that follows points out the consequences of these assumptions. *Id.* Willson, though, does not teach that significant misregistration renders the previous methods inoperable or unusable. *See id.* Nor does Willson disparage specific technical features in Morgan or Geng, apart from those shared with other color-imaging methods described in the abstract. *See id.*; *see also* Ex. 1057 ¶ 21 (discussing Willson’s abstract). Instead, Willson makes a general observation about the state of the art to provide context for the disclosed performance improvement: better registration of color images. *See* Ex. 2027, Abstract. Following Patent Owner’s argument to its logical conclusion would mean that Petitioner would have to account for every possible performance optimization. *See* PO Resp. 20–21. But the law of obviousness does not require that. Thus, we disagree with Patent Owner’s argument, and we assign the Sergienko Declaration little weight on this issue. *See id.*; Sergienko Decl. ¶ 52.

(5) *Obtaining Images “Virtually Simultaneous”*

In Patent Owner’s view, “Petitioner alleges that its combination would attain ‘virtually simultaneous’ 2D color and 3D scanning by using Geng’s switches.” PO Resp. 23 (citing Pet. 49, Ex. 1002 ¶ 91); *see also* Sur-reply 12–13. Patent Owner argues that the Morgan-Geng combination would fail to achieve this. PO Resp. 23–30. According to Patent Owner, Geng’s 3D scanning technology makes virtually simultaneous scanning possible, but Petitioner’s combination does not include Geng’s scanning. *Id.* at 24–25. Patent Owner asserts that, unlike Geng’s, Morgan’s scanning is a “comparatively long, drawn out and tedious process.” *Id.* at 26. Patent Owner argues that the reasons for this relate to how Morgan’s system captures the slices and assembles a 3D image. *See id.* at 26–30 (citing Sergienko Decl. ¶¶ 59–63).

Petitioner argues that Patent Owner mischaracterizes the Petition. Pet. Reply 12. Petitioner explains that the Petition “did not assert that the combination would result in ‘virtually simultaneous’ 3D and 2D color scanning in the same manner as Geng.” *Id.* According to Petitioner, “the petition explained how the POSA would have reasonably expected that the solution taught by Geng (i.e., two separate, switchable light sources) would allow Morgan’s device to perform 3D scanning while enabling color-imaging.” *Id.* (citing Pet. 49).

We agree with Petitioner that Patent Owner mischaracterizes the Petition in this way. *Id.* The relevant part of the Petition reads as follows:

Geng teaches using two separate light sources, one for 3D imaging and another for 2D color imaging, and controls to switch between the processes so 3D images and 2D color images can be obtained “virtually simultaneously.” EX1014, 4:31-35. A POSA would have understood this would help retain the resolution necessary for accurate 3D imaging in Morgan’s device by having one light source with limited “spectral bandwidth (to minimize chromatic aberration)” for the 3D scanning (EX1011, 14:3-13) while also having a second light source (e.g., a white light source) to enable color-imaging functionality. EX1002, ¶91.

Pet. 49 (emphasis added). The text emphasized above shows that the Petition explained that Geng obtains the images “virtually simultaneously.” *Id.* The Decision on Institution acknowledged this, stating that, “[a]ccording to the Petition, *Geng* teaches that controls ‘switch between the processes so 3D images and 2D color images can be obtained ‘virtually simultaneously.’” Inst. Dec. 10 (emphasis added). Thus, we disagree with Patent Owner’s interpretation that the Petition asserts that the “combination would attain ‘virtually simultaneous’ 2D color and 3D scanning” in the same way as Geng. PO Resp. 23; *see also* Sur-reply 13–14 (arguing that the Petition’s rationale was based on “virtually simultaneous” scanning).

As for Morgan's scanning speed, Patent Owner's performance analysis is based on, in part, on the zoom-lens embodiment. PO Resp. 28–29. As discussed above, neither the Petition nor Morgan requires a zoom lens. *See supra* § II.C.3.a). So, for reasons similar to those discussed above (*id.*), we disagree that Morgan must scan in the way that Patent Owner describes. *See* PO Resp. 28–29.

Rather, the record, including Dr. Sergienko's testimony, supports Petitioner's rebuttal that one of ordinary skill would have known how to configure the parameters of the Morgan-Geng system to obtain the desired scan speed. *See* Pet. Reply 13; Ex. 1056 73:7–22, 75:17–76:16. By contrast, Patent Owner's arguments (PO Resp. 26–30) fail to account for “the inferences and creative steps that a person of ordinary skill in the art would employ.” *KSR*, 550 U.S. at 418.

Even if a zoom lens were used, Patent Owner's reliance on Darrell (Ex. 2028) to show the performance of such a zoom lens in Morgan's system is flawed for similar reasons. PO Resp. 28. Although both Darrell and Morgan use a zoom lens, Patent Owner has not shown that the Morgan-Geng system would be sufficiently similar to Darrell's system to support the assertion that both would have the same performance characteristics—i.e., “‘bounded by the time it takes the focus and zoom motors to move through all focus positions’ which ‘is on the order of one second per focus position’, meaning that ‘a depth map with 10 levels of depth resolution [would be computed] in roughly 10 seconds’” *Id.* at 28–29 (quoting Ex. 2028, 508). Patent Owner does not account for how one of ordinary skill in the art would have configured the parameters of the Morgan-Geng system, such as motor speed. *See* Pet. Reply 13. Thus, Patent Owner's arguments and the Sergienko Declaration are not sufficiently supported by the record. PO Resp.

26–30 (citing Sergienko Decl. ¶¶ 59–63). So we accord the Sergienko Declaration little weight on these issues. *See* Sergienko Decl. ¶¶ 59–63.

For the reasons discussed, we determine that Petitioner provides articulated reasoning, supported by rational underpinnings, why one of ordinary skill in the art would have combined Morgan and Geng. *See KSR*, 550 U.S. at 418. Based on Petitioner’s analysis, we find that a person of ordinary skill in the art would have modified Morgan with Geng to obtain the recited color image sensor. *See* Pet. 23–24, 31–32.

c) Lighting Equipment

Claim 17 recites, in part, “lighting equipment configured to generate a probe light.” Ex. 1001, 38:46–47.

Petitioner asserts that Morgan’s scanner has a structured light source with a lamp, a projector lens, and a grid or spatial filter. Pet. 24 (citing Ex. 1011, 3:29–32). Patent Owner does not substantively address this analysis. *See* PO Resp.; Sur-reply. Petitioner sufficiently shows that Morgan teaches a probe light, as in claim 17, because the scanner’s lamp illuminates the object with a structured-light pattern. *Id.* (citing Ex. 1011, Abstract, 8:23–39, Figs. 1–2).

d) Optical System

Claim 17 recites, in part, “an optical system comprising a beam splitter, at least one lens, and a tip configured to be inserted into the oral cavity.” Ex. 1001, 38:47–49.

Petitioner asserts that the Morgan-Geng combination teaches this limitation. Pet. 24. In particular, Petitioner asserts that Morgan’s system includes lens system 2, i.e., the recited optical system, and beam-splitter 8. *Id.* (citing Ex. 1011, Abstract, 3:22–25, 3:29–34, Fig. 1). We agree that Morgan teaches this arrangement of optical components. *See id.* As for

whether this is “configured to be inserted into the oral cavity,” Petitioner asserts that Morgan’s scanner maps surfaces in a patient’s mouth. *Id.* at 25 (citing Ex. 1011, 16:7–20).

Geng’s device is shown in Figure 1 below.

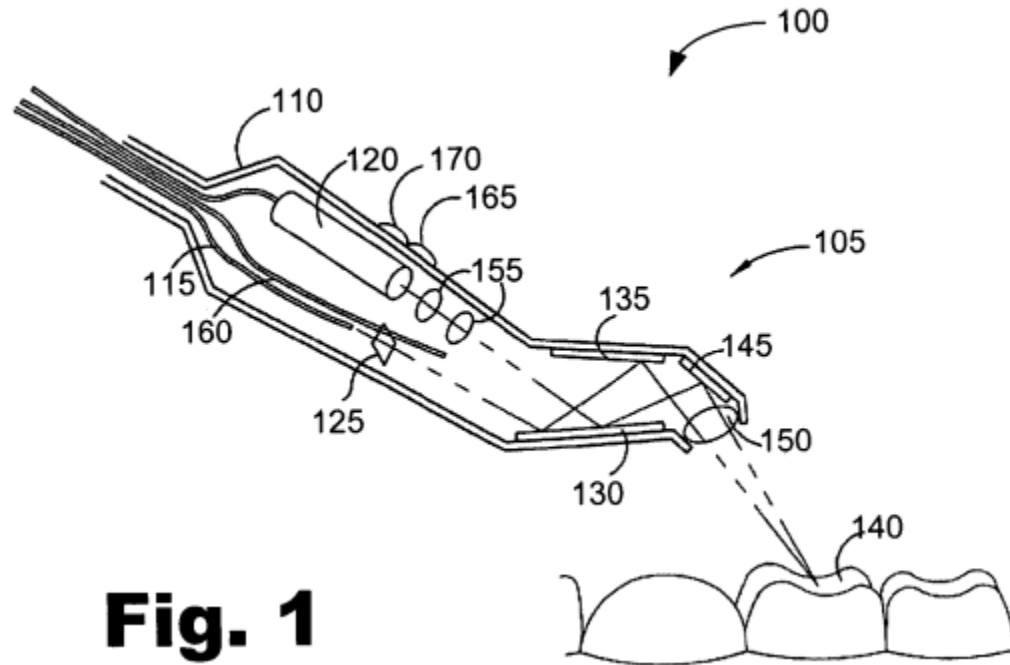


Fig. 1

Geng’s Figure 1, above, is a schematic representation of the intraoral camera (100) and shows a dental structure (140). Ex. 1014, 3:13–14.

Geng’s system, above, includes intraoral probe 105 with housing 110 encompassing CCD 120. Ex. 1014, 3:53–58.

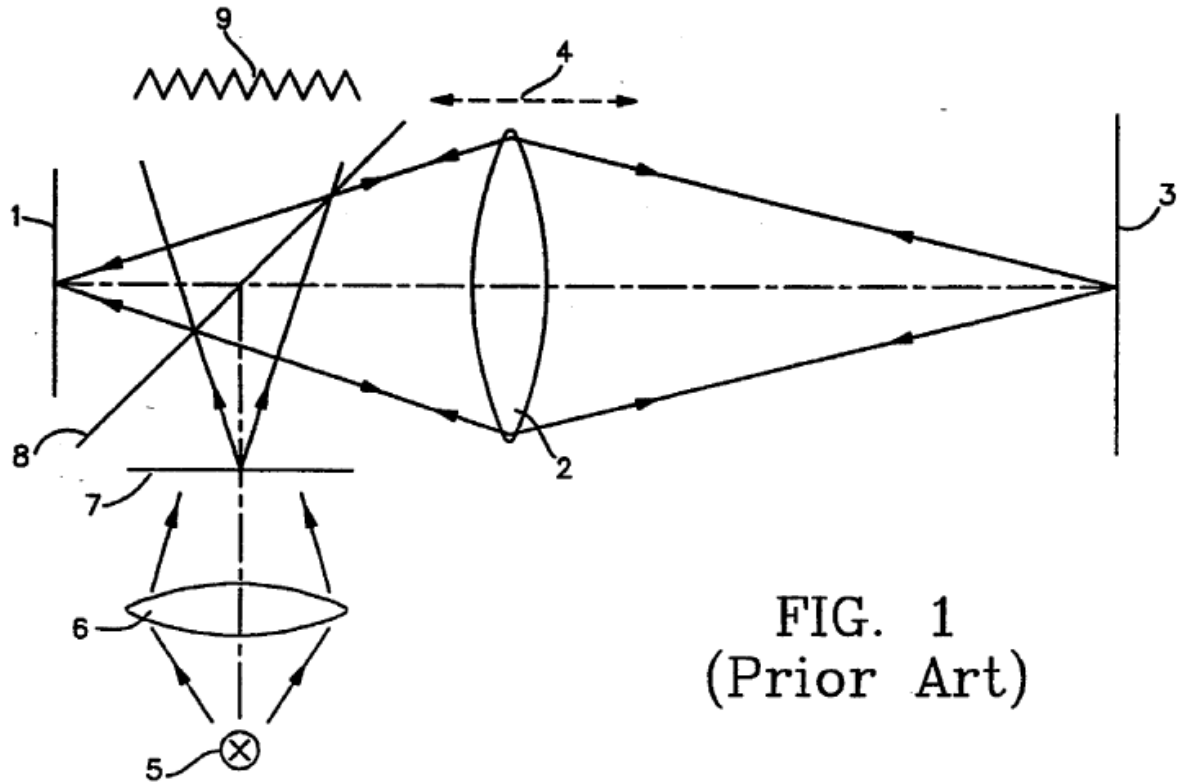
According to Petitioner, a person of ordinary skill in the art would have configured Morgan’s scanner to include Geng’s tip “as a beneficial way of imaging an intraoral surface.” Pet. 26 (citing Hesselink Decl. ¶ 114).

Apart from the limitation to “a tip configured to be inserted into the oral cavity,” Patent Owner does not substantively address this analysis. *See supra* § II.C.3.a) (analyzing the tip limitation and Patent Owner’s arguments). Upon review of the entirety of the record, we are persuaded by

Petitioner's evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 24–26; Hesselink Decl. ¶¶ 110–114; *see also supra* § II.C.3.a). Petitioner sufficiently shows that “an optical system comprising a beam splitter, at least one lens, and a tip configured to be inserted into the oral cavity,” as recited in claim 17, would have been obvious in view of the Morgan-Geng combination.

e) Focus-Plane Translation

Claim 17 recites, in part, “wherein the intraoral scanner is configured to operate by translating a focus plane along an optical axis of the optical system to capture one or more 2D images.” Ex. 1001, 38:50–52. Petitioner asserts that Morgan teaches this limitation. Pet. 26. In particular, Petitioner asserts that Morgan's lens system 2 is successively positioned at hundreds of discrete, pre-calculated positions to focus different slices of object 3 on detector 1. *Id.* (citing Ex. 1011, 3:25–27, 3:45–51, 8:13–17, Figs. 1, 3). Petitioner asserts that Morgan's device translates lens system 2 along the optical axis. *Id.* (citing Ex. 1011, Fig. 1). Morgan illustrates the device's basic concept in Figure 1.



Morgan’s Figure 1, above, illustrates an optical sensor including the main components and the optical pathways between them. Ex. 1011, 2:52–55.

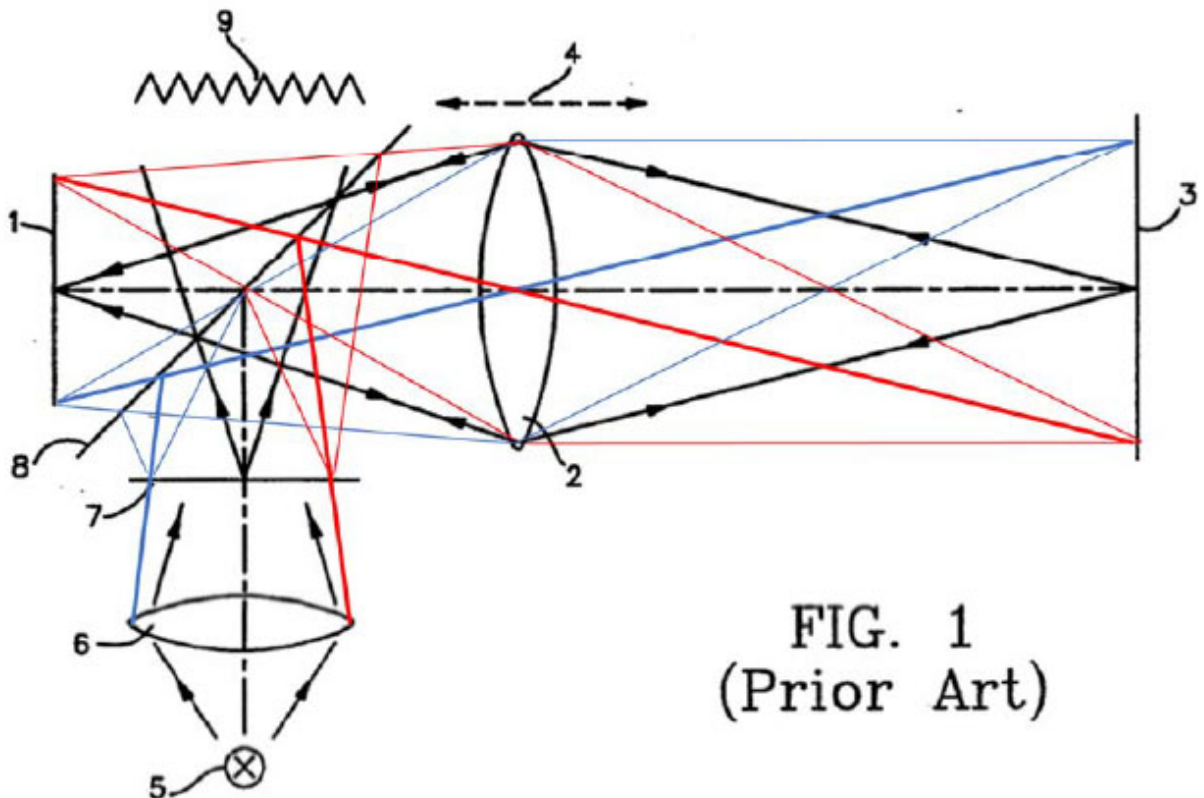
In Figure 1, above, positioning means 4 moves the lens along the axis represented by a dashed line. *See id.* at 3:24–27, Fig. 1. This translates the focus plane relative to object 3, according to the passages cited in the Petition. *See, e.g., id.* at 3:25–27, 45–51 (discussing adjusting focus to create “slices”), *cited in* Pet. 26.

Patent Owner does not substantively address this analysis. Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 26–27; Hesselink Decl. ¶¶ 117–118. Thus, we determine that Petitioner sufficiently shows that Morgan teaches “translating a focus plane along an optical axis of the optical system to capture one or more 2D images,” as recited in claim 17.

f) Probe-Light Transmission

Claim 17 recites, in part, “wherein the at least one lens is configured such that the intraoral scanner transmits at least a part of the probe light from the lighting equipment through the optical system and towards the object such that the at least a part of the probe light is non-telecentrically focused on at least a part of the surface of the object.” Ex. 1001, 38:52–58.

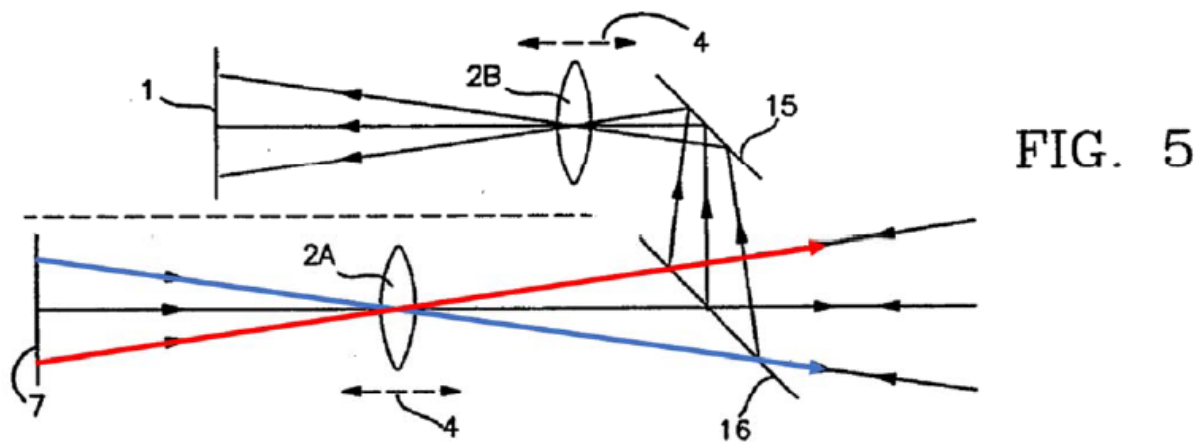
Petitioner asserts that Morgan teaches this limitation. Pet. 26. According to Petitioner, “the term ‘non-telecentric’ denotes the non-parallel travel of chief rays through a lens system, resulting in magnification changes across focus-plane positions.” *Id.* at 21. Petitioner annotates Figure 1 to show that Morgan’s system focuses light non-telecentrically. *Id.* at 26.



Morgan’s Figure 1, as annotated by Petitioner, shows light transmitted through the optical system. *Id.* at 28 (citing Hesselink Decl. ¶¶ 122–123).

Petitioner asserts that the light transmitted through the optical system includes multiple ray bundles having non-parallel chief rays focused on the object. *Id.* (citing Hesselink Decl. ¶¶ 122–123). Those rays are shown above by red and blue lines. *Id.* As annotated, those lines are non-parallel.

Petitioner also asserts that Figure 5, reproduced below, shows non-parallel chief rays. *Id.* at 28.



Morgan’s Figure 5, as annotated by Petitioner, shows another lens arrangement. *Id.* (citing Ex. 1011, 9:52–57, Fig. 5; Hesselink Decl. ¶ 124).

Petitioner asserts that Figure 5 of Morgan shows multiple chief rays propagating from grid 7 and through lens 2A and beam-splitter 16 to an object. *Id.* (citing Ex. 1011, 9:52–57, Fig. 5; Hesselink Decl. ¶ 124). The reflected rays are imaged by detector 1. *Id.* Petitioner highlights the two chief rays in red and blue. *Id.* As shown, those lines are non-parallel.

Upon review of this record, we agree with Petitioner that the part of the probe light from the lighting equipment through the optical system and towards the object is non-telecentrically focused on at least a part of the surface of the object. *Id.*

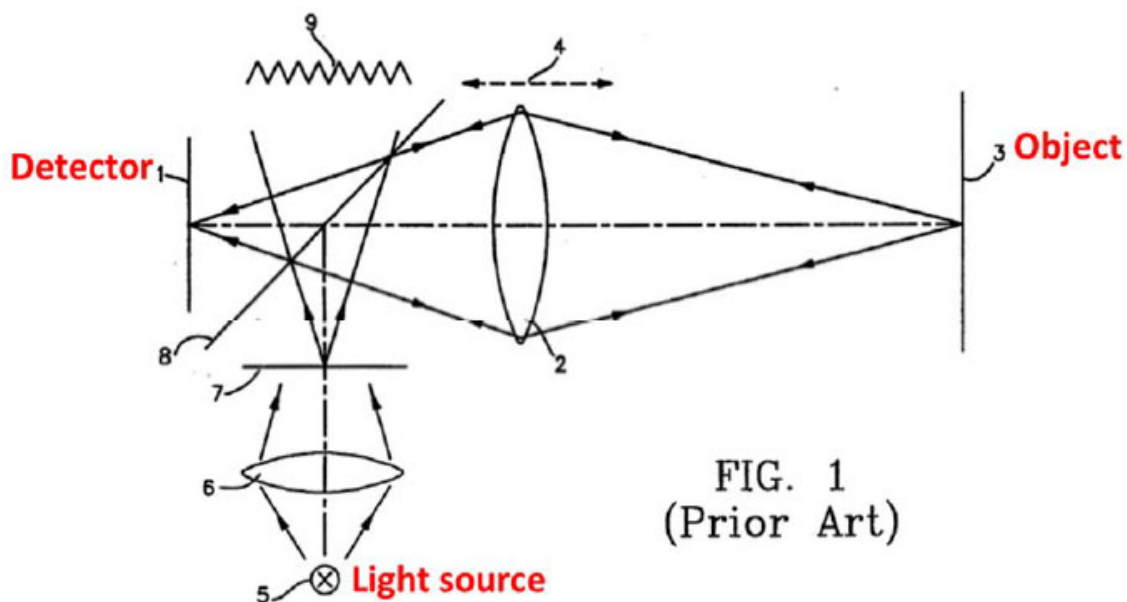
Patent Owner does not substantively address this analysis. Upon review of the entirety of the record, we are persuaded by Petitioner’s

evidence and obviousness analysis, and we credit the Hesselink Declaration. *Id.* at 27–29; Hesselink Decl. ¶¶ 122–124. Thus, we determine that Petitioner shows that Morgan teaches that “at least a part of the probe light is non-telecentrically focused on at least a part of the surface of the object” using the arrangement recited in claim 17.

g) Probe-Light Reflection

Claim 17 recites, in part, “wherein reflected light results from the at least a part of the probe light being reflected from the at least a part of the surface of the object.” Ex. 1001, 38:58–60.

Petitioner asserts that, in Morgan, projecting the structured light pattern onto the object causes light to be reflected. Pet. 29 (citing Ex. 1011, Abstract, 1:55–60, 3:22–25, 5:43–6:22). Petitioner asserts that this is shown in Morgan’s Figure 1, which is reproduced below with Petitioner’s annotations. *Id.*



Morgan’s Figure 1, as annotated by Petitioner, shows probe light reflecting from object 3 and transmitting back to detector 1 for imaging. *Id.* at 29–30 (citing Hesselink Decl. ¶¶ 128–130).

Indeed, Figure 1 above shows light from lamp 5 focused on object 3, through lens system 2, and reflected from object 3 back to detector 1.

Ex. 1011, Fig. 1.

Patent Owner does not substantively address this analysis. Upon review of the entirety of the record, we are persuaded by Petitioner's evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 29–30; Hesselink Decl. ¶¶ 128–130. Thus, we determine that Petitioner shows that Morgan teaches “wherein reflected light results from the at least a part of the probe light being reflected from the at least a part of the surface of the object,” as recited in claim 17.

h) Reflected-Light Transmission

Claim 17 recites, in part, “wherein the intraoral scanner is further configured to transmit the reflected light from the at least a part of the surface of the object back through the optical system such that the reflected light is focused on the color image sensor.” Ex. 1001, 38:60–64.

Petitioner asserts that Morgan's optical system forms a secondary image of the pattern-illuminated object on the detector. Pet. 30 (citing Ex. 1011, Abstract; Hesselink Decl. ¶ 134). Petitioner asserts that, to form this image, the light reflected from the object must be transmitted back through the optical system and focused on the detector. *Id.*

We determine that Figure 1, as annotated by Petitioner, shows reflected light traveling through the optical system (lens 2 and beam splitter 8) to detector 1. *Id.* According to Petitioner, a person of ordinary skill in the art would have found it beneficial to use a color image sensor as a detector in Morgan's confocal scanning system in view of Geng. *Id.* at 30–31 (citing Hesselink Decl. ¶ 135). For the reasons discussed above, Petitioner's

rationale for adding Geng's color image sensor to Morgan is persuasive. *See supra* § II.C.3.b).

Patent Owner does not substantively address this analysis. Upon review of the entirety of the record, we are persuaded by Petitioner's evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 30–31; Hesselink Decl. ¶¶ 132–136. Thus, we determine that Petitioner shows that “wherein the intraoral scanner is further configured to transmit the reflected light from the at least a part of the surface of the object back through the optical system such that the reflected light is focused on the color image sensor,” as recited in claim 17, would have been obvious in view of the Morgan-Geng combination.

i) Image-Series Generation

Claim 17 recites, in part, “at least one of the series of 2D images being generated using the reflected light focused on the color image sensor.” Ex. 1001, 38:67–39:2.

Petitioner asserts that Morgan's confocal scanner illuminates the object with a patterned probe light. Pet. 32 (citing Hesselink Decl. ¶ 143). According to Petitioner, this illumination reflects light back through the optical system and focuses the reflected light on the detector. *Id.* Petitioner asserts that Morgan's scanner then captures 2D images generated from the reflected light. *Id.* (citing Ex. 1011, Abstract, 1:55–58, 3:22–25, 5:43–6:22, Figs. 1, 3).

Morgan supports Petitioner's assertion: The paragraph cited in the Petition explains that Morgan's lens system 2 focuses object 3's image on detector 1. Ex. 1011, 3:20–25. And, for the reasons discussed above, Petitioner's rationale for adding Geng's color image sensor to Morgan is persuasive. *See supra* § II.C.3.b).

Patent Owner does not substantively address this analysis. Upon review of the entirety of the record, we are persuaded by Petitioner's evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 32; Hesselink Decl. ¶¶ 142–145. Thus, we determine that Petitioner shows that “at least one of the series of 2D images being generated using the reflected light focused on the color image sensor,” as recited in claim 17, would have been obvious in view of the Morgan-Geng combination.

j) Conclusion

Petitioner has shown by a preponderance of the evidence that claim 17 is unpatentable as obvious over Morgan and Geng. Pet. 22–32.

4. Independent Claim 1

Claim 1 recites limitations similar to those recited in claim 17. *See* Ex. 1001, 37:19–52 (claim 1). But the claims are not identical. Specifically, claim 17 recites that the probe light is “non-telecentrically focused” on the object. *Id.* at 38:52–58. By contrast, claim 1 recites (1) at least a part of the probe light is “focused onto at least two different parts of the object”; (2) “the at least a part of probe light as focused on a first part of the object is defined by a first divergence angle in relation to a first propagation axis”; (3) “the at least a part of probe light as focused on a first part of the object is defined by a second divergence angle in relation to a second propagation axis”; and (4) “the first propagation axis and the second propagation axis are non-parallel.” *Id.* at 37:31–40.

Petitioner asserts that claim 1 is met by “an intraoral scanner with ‘a non-telecentric optical configuration at the object,’” which Petitioner asserts is taught by Morgan. Pet. 33. Under Petitioner's rationale, “the claimed ‘propagation axis’ appears to refer to the path that a chief ray travels as it focuses on the object, the claimed ‘at least to different parts of the object’

appears to refer to at least two different points on the object, and the claimed ‘divergence angle’ appears to refer to the chief ray’s angle of deviation from the optical axis.” *Id.* at 33–39.

Patent Owner does not substantively address Petitioner’s assertions. *See* PO Resp.; Sur-reply. Rather, Patent Owner argues, claim 1 “would not have been obvious for at least the reasons discussed with respect to independent claim 17,” and “[i]t would not have been obvious to combine Morgan and Geng with a reasonable expectation of success for the reasons discussed” in connection with claim 17. PO Resp. 30. For the reasons discussed in the sections analyzing claim 17, we disagree with Patent Owner’s arguments. *Supra* § II.C.3.

Also, we agree with Petitioner’s assertions specific to claim 1. Pet. 33–39. The Petition contains ray-tracing diagrams to show the non-telecentric optical configuration. *Id.* And the Petition shows how Morgan’s ray bundles in Figure 1 are focused on two different parts of the object (P1 and P2), are defined by a first divergence angle D1 in relation to propagation axis Pr1 relative to the optical axis, and include a chief ray defined by a second divergence angle D2 in relation to a second propagation axis Pr2 relative to the optical axis. *Id.* (showing Figure 1 with Petitioner’s annotations and labels) (citing Hesselink Decl. ¶¶ 146–155).

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 33–39; Hesselink Decl. ¶¶ 146–155. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claim 1 is unpatentable as obvious over Morgan and Geng. *See* Pet. 33–39.

5. Independent Claim 19

Claim 19 recites a method with steps substantially similar to the functional limitations of claim 17. *See* Ex. 1001, 39:8–31. Petitioner asserts that claim 19’s “method requires performing the steps each of the components are configured to perform in claim 17.” Pet. 39. Petitioner asserts that “Morgan and Geng teach an intraoral scanner configured to perform the steps recited in claim 17, the analysis presented [in connection with claim 17] applies equally to claim 19.” *Id.* (citing Hesselink Decl. ¶¶ 156–157).

Patent Owner does not substantively address Petitioner’s arguments and evidence regarding claim 19. *See* PO Resp.; Sur-reply. Rather, Patent Owner argues, claim 19 “would not have been obvious for at least the reasons discussed with respect to independent claim 17,” and “[i]t would not have been obvious to combine Morgan and Geng with a reasonable expectation of success for the reasons discussed” in connection with claim 17. PO Resp. 30. For the reasons discussed in the sections analyzing claim 17, we disagree with Patent Owner’s arguments. *Supra* § II.C.3.

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 39; Hesselink Decl. ¶¶ 156–157. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claim 19 is unpatentable as obvious over Morgan and Geng. *See* Pet. 39.

6. Independent Claim 21

Claim 21 recites a method with steps substantially similar to the functional limitations of claim 1. *See* Ex. 1001, 39:8–31. Instead of the recited non-parallel first and second propagation axes, as in claim 1, claim

21 requires that the first propagation axis diverge from the second propagation axis. *See id.*

According to Petitioner, “Morgan teaches a normal lens configuration, which includes chief rays that focus onto the object in a non-parallel manner, including where the rays diverge relative to another, as shown in the annotated FIGS. 1, 5 above.” Pet. 40 (citing Sections VII.A.1.a.vi and VII.A.1.b of the Petition).

Patent Owner does not substantively address Petitioner’s arguments and evidence regarding claim 21. *See* PO Resp.; Sur-reply. Rather, Patent Owner argues, claim 21 “would not have been obvious for at least the reasons discussed with respect to independent claim 17,” and “[i]t would not have been obvious to combine Morgan and Geng with a reasonable expectation of success for the reasons discussed” in connection with claim 17. PO Resp. 30. For the reasons discussed in the sections analyzing claim 17, we disagree with Patent Owner’s arguments. *See supra* §§ II.C.3–4.

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 40; Hesselink Decl. ¶¶ 158–159. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claim 21 is unpatentable as obvious over Morgan and Geng. *See* Pet. 40.

7. Claim 2

Claim 2 recites, “The intraoral scanner according to claim 1, wherein the lighting equipment comprises a white light source configured to generate white light, the intraoral scanner being further configured to focus the white light on the color image sensor, the color image sensor being configured to produce data for color of the at least a part of the surface of the object from the white light focused on the color image sensor.” Ex. 1001, 37:53–59.

Petitioner asserts that a person of ordinary skill in the art “would have had reason to use a color image sensor for capturing color data of the object.” Pet 40 (citing Sections VII.A.1.a.ii and VII.A.3 of the Petition). According to Petitioner, “Geng teaches using a white light source (e.g., second fiber optic bundle 160) that generates a white light focused on a CCD for color image sensing,” and “CCD produces color data of the object’s surface.” *Id.* at 40–41 (citing Ex. 1014, 3:53–58, 3:64–4:2, 4:21–35, 5:5–10, 5:21–34; Hesselink Decl. ¶¶ 162–164).

Patent Owner does not substantively address the arguments and evidence regarding claim 2. *See* PO Resp.; Sur-reply.

For the reasons discussed above in connection with the Geng’s color image sensor, we agree with Petitioner’s assertions here, which address features similar to those recited in claim 17 and are based on a similar obviousness rationale. *See supra* § II.C.3.b). Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 40–41; Hesselink Decl. ¶¶ 162–164. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claim 2 is unpatentable as obvious over Morgan and Geng. *See* Pet. 40–41.

8. *Claim 3*

Claim 3 recites, “The intraoral scanner according to claim 1, wherein the tip is a distal end of the intraoral scanner from which the probe light is emitted toward the at least a part of the surface of the object.” Ex. 1001, 37:60–63.

Petitioner asserts that Geng’s tip is located at a distal end, nearest the scanned object, and the tip illuminates the object. Pet. 41 (citing EX1014, 3:55–56, 5:30–34, 5:58–6:11, Figs. 1-4; Hesselink Decl. ¶¶ 168–171).

According to Petitioner, a person of ordinary skill in the art “would have readily appreciated such a tip should be included in a scanner like Morgan’s for similarly emitting light toward an intraoral object’s surface.” *Id.*

Patent Owner does not substantively address the arguments and evidence regarding claim 3. *See* PO Resp.; Sur-reply.

For the reasons discussed above in connection with the Geng’s tip, we agree with Petitioner’s assertions here, which address features similar to those recited in claim 17 and are based on a similar obviousness rationale. *See supra* § II.C.3.a). Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 41; Hesselink Decl. ¶¶ 168–171. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claim 3 is unpatentable as obvious over Morgan and Geng. *See* Pet. 41.

9. Claims 6–8

Claims 6–8 further limit the intraoral scanner, in part, by defining an “image measure.” In particular, claim 6 recites, “The intraoral scanner according to claim 1, wherein the data for the 3D geometry is derived by calculating an image measure for several 2D images of the series of 2D images.” Ex. 1001, 38:1–3. Claim 7 recites, “The intraoral scanner according to claim 6, wherein the image measure is defined for a selected part within the several 2D images, and wherein the image measure for the several 2D images has a maximum value corresponding to a position along the optical axis of the optical system.” *Id.* at 38:4–8. Claim 8 recites, “The intraoral scanner according to claim 7, wherein the at least one lens of the optical system includes a movable lens, and the position along the optical axis corresponds to a position of the movable lens.” *Id.* at 38:9–12.

For these limitations, Petitioner points to Morgan’s process for illuminating the object with patterned light. Pet. 42. In particular, Petitioner asserts that Morgan teaches calculating brightness and a high-pass component of the received intensity signals as the recited “image measure.” *Id.* Petitioner asserts that Morgan does so “for several 2D images (e.g., grid pattern imaged in both light/dark areas) where the image measure is defined for a selected part within the several 2D images (e.g., each pixel or group of pixels) and has a maximum value corresponding to a position along the optical axis of the optical system (e.g., maximum high pass component defines in-focus distance of object relative to scanner . . .).” *Id.* (citing Ex. 1011, 3:51–64, 6:67–7:3). In Petitioner’s view, “The position along the optical axis corresponds to a position of [a] movable lens (e.g., movable lens 2 defines focus-plane position).” *Id.* at 42–43 (citing Hesselink Decl. ¶¶ 174–175).

Patent Owner does not substantively address the arguments and evidence regarding claims 6–8. *See* PO Resp.; Sur-reply.

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and analysis, and we credit the Hesselink Declaration. Pet. 42–43; Hesselink Decl. ¶¶ 172–181. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claims 6–8 are unpatentable as obvious over Morgan and Geng. *See* Pet. 42–43.

10. Claim 10

Claim 10 recites, “The intraoral scanner according to claim 1, further comprising a data processing system configured to process the data for the 3D geometry.” Ex. 1001, 38:17–19.

According to Petitioner, Morgan’s scanner includes computer 12 for processing the detector’s signals to determine the object’s 3D surface

geometry. Pet. 43 (citing Ex. 1011, Abstract, 4:25–34, 8:13–22; Hesselink Decl. ¶¶ 182–186).

Patent Owner does not substantively address the arguments and evidence regarding claim 10. *See* PO Resp.; Sur-reply.

We agree with Petitioner that Morgan’s computer 12 carries out the functions of the recited data-processing system. Pet. 43. According to Morgan, computer 12 has a signal processor, and monitor 12 displays the signal processor’s output:

The control units 9, 10 and 11, together with the output of the CCD detector 1, are connected to a computer 12 provided with an image processor, frame grabber, frame stores (computer memory corresponding to the pixel array of the detector 1) and a digital signal processor (DSP) 13 for processing the signals received and providing appropriate instructions to the control units. The output of the signal processor may then be displayed on a monitor 14.

Ex. 1011, 4:25–34, *cited in* Pet. 43.

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 43; Hesselink Decl. ¶¶ 182–186. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claim 10 is unpatentable as obvious over Morgan and Geng. *See* Pet. 43.

11. Claim 13

Claim 13 recites, “The intraoral scanner according to claim 1, wherein the data for the 3D geometry is derived by identifying at which distance from the intraoral scanner the object surface is in focus for a block of image sensor pixels.” Ex. 1001, 38:27–29.

Petitioner asserts that “Morgan teaches deriving the object’s 3D geometry by calculating the high-contrast, in-focus points of the object at a

given focus-plane position (i.e., the distance from the scanner to the object), which allows the system to map the 2D contour ‘slices’ into a full 3D model of the object.” Pet. 43 (citing Ex. 1011, 3:24–26, 3:51–64). According to Petitioner, “Morgan teaches the intensity calculations may be performed based on a ‘group of pixels’ (i.e., a block of image sensor pixels).” *Id.* at 44 (citing Ex. 1011, 6:46–49; Hesselink Decl. ¶¶ 187–90).

Patent Owner does not substantively address the arguments and evidence regarding claim 10. *See* PO Resp.; Sur-reply.

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 43–44; Hesselink Decl. ¶¶ 187–190. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claim 13 is unpatentable as obvious over Morgan and Geng. *See* Pet. 43–44.

12. Claims 14 and 15

Claim 14 recites, “The intraoral scanner according to claim 10, wherein the data processing system is configured to derive the data for the 3D geometry by calculating an image measure for several 2D images of the series of 2D images, wherein the data processing system is configured to map the several 2D images to a 3D image.” Ex. 1001, 38:31–36. Claim 15 recites, “The intraoral scanner according to claim 14, wherein the data processing system is configured to map the several 2D images to a 3D image based on backward ray tracing.” *Id.* at 38:37–39.

As for claim 14, Petitioner asserts that “Morgan teaches calculating an image measure (e.g., brightness I and high pass component M) for several 2D images using computer 12” and “computer 12 is also configured to map the individual 2D contour maps into a 3D surface model map.” Pet. 44 (citing Ex. 1011, 4:25–34, 7:4–12, 8:13–22, 5:63–7:12, Figs. 2–3; Hesselink

Decl. ¶ 193). As for claim 15, Petitioner asserts that a person of ordinary skill in the art “would have understood the mapping could be performed by backward ray tracing, which was a well-known and routinely-used technique for determining displacement between a light source (e.g., the object) and a receiver (e.g., the image sensor)” and “that by tracing the reflected light’s path from the image sensor back to the object, and given known variables of the optical system, the distance between the lens system and the in-focus object could be more efficiently determined.” *Id.* at 44–45 (citing Ex. 1011, 3:51–64; Hesselink Decl. ¶¶ 195–196).

Patent Owner does not substantively address the arguments and evidence regarding claims 14 and 15. *See* PO Resp.; Sur-reply.

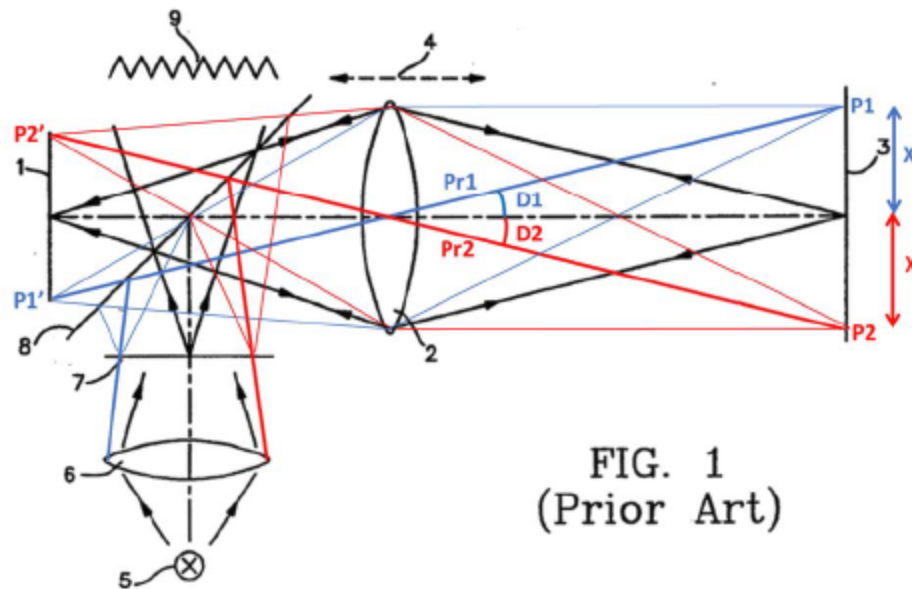
Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 44–45; Hesselink Decl. ¶¶ 193–196. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claims 14 and 15 are unpatentable as obvious over Morgan and Geng. *See* Pet. 44–45.

13. Claim 16 and 22

Claim 16 recites, “The intraoral scanner according to claim 1, wherein the first divergence angle and the second divergence angle are identical.” Ex. 1001, 38:40–42. Claim 22 recites substantially similar limitations to claim 16: “The intraoral scanner according to claim 21, wherein the first divergence angle and the second divergence angle are identical.” *Id.* at 39:32–39.

As discussed in connection with claim 1, Petitioner asserts that the chief rays propagating through Morgan’s non-telecentric lens system each include a “propagation axis” and a “divergence angle.” *See supra* § II.C.4.; Pet. 45. Supported by the Hesselink Declaration, the Petition explains that

“the first divergence angle and the second divergence angle’ would be identical for chief rays focused on symmetrically spaced off-axis points.” Pet. 45 (citing Hesselink Decl. ¶ 201); *id.* at 47 (citing Hesselink Decl. ¶ 212). Petitioner illustrates this by annotating Morgan’s Figure 1, below. *Id.* at 45–46.



Annotated Figure 1, above, shows off-axis points P1 and P2 spaced equally apart from the optical axis by distance X. *Id.* at 46. According to the Petition, this results in identical divergence angles D1 and D2. *Id.* Petitioner explains that the analysis for claim 16 applies equally to claim 22. *Id.* at 47.

Patent Owner does not substantively address the arguments and evidence regarding claims 16 and 22. *See* PO Resp.; Sur-reply.

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 45–46; Hesselink Decl. ¶ 201. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claims 16 and 22 are unpatentable as obvious over Morgan and Geng. *See* Pet. 45–47.

14. Claim 18

Claim 18 recites, “The intraoral scanner according to claim 17, wherein at least a part of the probe light is modeled to include a plurality of ray bundles, each of which includes a chief ray, and the chief rays of the plurality of ray bundles diverge from the tip to the at least a part of the surface of the object.” Ex. 1001, 39:3–7.

Petitioner asserts that “Morgan teaches an optical system that non-telecentrically focuses light onto the object surface and illustrates diverging chief rays toward the object (i.e., diverge from the tip to the at least part of the surface of the object).” Pet. 46–47 (citing the analysis of claims 17 and 1 in sections VII.A.1.a.vi and VII.A.1.b of the Petition); Hesselink Decl. ¶ 206. As discussed in connection with claims 17 and 1, Petitioner has shown that Morgan teaches this feature. *See supra* §§ II.C.3 (claim 17), II.C.4 (claim 1).

Patent Owner does not substantively address the arguments and evidence regarding claim 18. *See* PO Resp.; Sur-reply.

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 46–47; Hesselink Decl. ¶ 206. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claim 18 is unpatentable as obvious over Morgan and Geng. *See* Pet. 46–47.

15. Claim 20

Claim 20 recites, “The method according to claim 19, comprising calibrating the optical system by performing the steps of: (a) creating a look-up table mapping 3D coordinates corresponding to all pixels of an image formed by the color image sensor, by performing backward ray tracing at

each pixel; and (b) repeating the step (a) for a number of different focus positions of the at least one lens.” Ex. 1001, 39:32–39.

Petitioner asserts that a person of ordinary skill in the art “would have understood backward ray tracing to be a routine method for mapping 3D coordinates to the 2D images” and that “[a] conventional method to map the coordinates is by creating a look-up table, which stores the Z-coordinate at which each pixel will be in focus.” Pet. 47 (citing Ex. 1025, 2:46–59, 3:29–32, 8:15–34; Ex. 1026, 4:55–59, 17:29–37, 20:30–38; Ex. 1029, 398). According to Petitioner, “mapping should be performed for all focus-plane positions so that when a pixel is determined as in-focus, the corresponding Z-coordinate can be efficiently identified.” *Id.*

Patent Owner does not substantively address the arguments and evidence regarding claim 20. *See* PO Resp.; Sur-reply.

Upon review of the entirety of the record, we are persuaded by Petitioner’s evidence and obviousness analysis, and we credit the Hesselink Declaration. Pet. 47; Hesselink Decl. ¶ 210. Thus, we determine that Petitioner has shown by a preponderance of the evidence that claim 20 is unpatentable as obvious over Morgan and Geng. *See* Pet. 47.

D. Obviousness over Morgan, Geng, and Bayer

Petitioner asserts that claims 4, 5, and 9 are unpatentable as obvious over Morgan, Geng, and Bayer. Pet. 50–51.

Claims 4, 5, and 9 recite limitations drawn to a color filter array: Claim 4 recites, “The intraoral scanner according to claim 1, wherein the color image sensor comprises a color filter array.” Ex. 1001, 40:36–38. Claim 5 recites, “The intraoral scanner according to claim 4, wherein the color filter array is a Bayer filter array.” *Id.* at 37:66–67. Claim 9 recites, “The intraoral scanner according to claim 4, wherein the color filter array

comprises at least three types of color filters, each color filter allowing light in a known wavelength range to propagate through the color filter.” *Id.* at 38:13–16.

As for these claims, Petitioner asserts that “Bayer teaches an element array (known as a ‘Bayer filter array’) having at least three types of color filters (e.g., red, green, and blue) superposed on a solid-state sensor array (e.g., CCD) to enable color imaging.” Pet. 50 (citing Ex. 1016, 2:45–57, 3:51–4:2, Figs. 1A–1B). According to Petitioner, “Bayer teaches the array enables color image sensing to ‘occur at a single imaging site, e.g., at a single planar photosensitive array,’ which ‘avoid[s] optical complexity and problems with image registration.’” *Id.* (citing Ex. 1016, 1:10–14, 2:45–57).

Petitioner’s rationale for using the Bayer filter array, described by Bayer, is that “it would allow for color sensing to occur simultaneously at a single imaging site, and a reasonable expectation of success in doing so because Bayer teaches that the array provides an efficient use of the image sensor while still sufficiently emulating the human visual response, and use of a Bayer filter array was conventional at the relevant time.” *Id.* (citing Ex. 1016, 3:14–25; Hesselink Decl. ¶¶ 213–16).

According to Patent Owner, Petitioner has not shown that a person of ordinary skill in the art would have had a reason to modify the Morgan-Geng combination with Bayer because (1) Geng’s 2D scanning already provides simultaneous color scanning and (2) Morgan already uses a limited bandwidth filter in front of the detector to match the light source. PO Resp. 31 (citing Sergienko Decl. ¶ 66); *see also* Sur-reply 14–15.

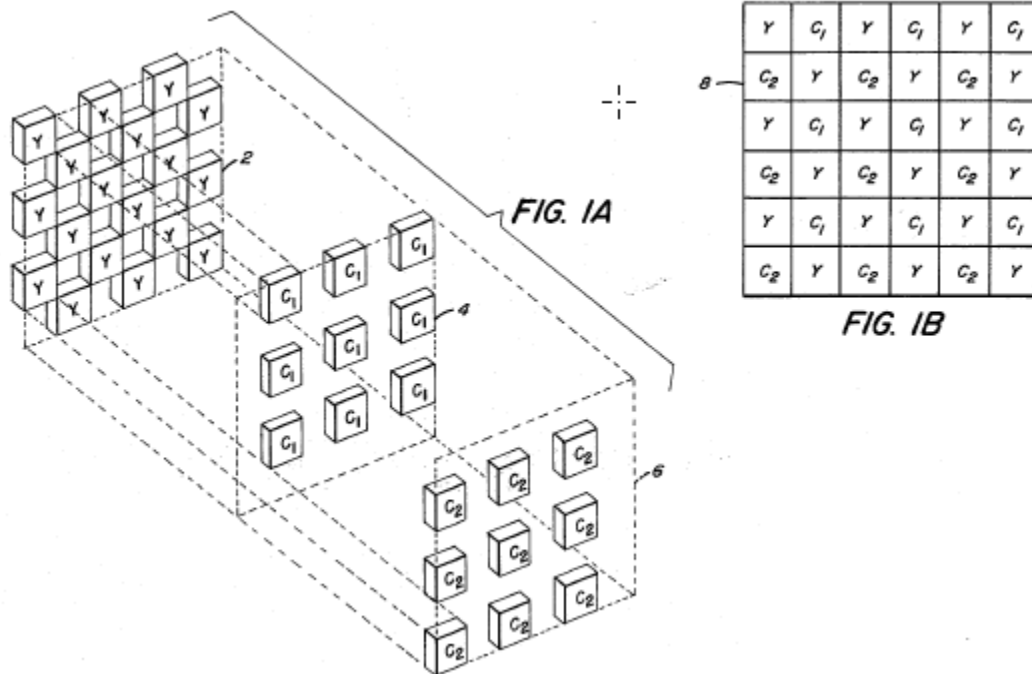
As for Petitioner’s stated reason, Patent Owner argues that Petitioner has not sufficiently explained how Bayer’s filter array would provide for “simultaneous color sensing.” PO Resp. 31 (citing Pet. 50). In Patent

Owner's view, the cited passages do not discuss simultaneous color sensing, but instead, they merely describe the green, red, and blue filters for the sensor. *Id.* (citing Ex. 106, 1:10–14, 2:45–57).

We disagree with Patent Owner because, by referencing “simultaneous color sensing,” Petitioner is relying on the advantages of using a Bayer filter. *See* Pet. 50. In the background of the invention, Bayer describes known approaches⁷ to “single-site color sensing devices,” which produce “field sequential” color signals. Ex. 1016 1:18–30, *cited in* Pet. Reply 13. Such approaches use a sensor with a cooperating filter disc. *Id.* at 1:18–22. The filter disc passes a series of color filters through the image beam in a repeating sequence. *Id.* The filter interpositions are synchronized to the image scanning, with the filter interposed during an entire field scan. *Id.* at 1:22–24.

By contrast, Bayer teaches that the filter array allows for color sensing to occur simultaneously, as Petitioner asserts. Pet. 50 (citing Ex. 1016, 3:14–25). Bayer's Figures 1A and 1B, below, show how the filter array works. Ex. 1016, Figs. 1A, 1B, *discussed in* Pet. 50.

⁷ We note that Bayer was published in 1976. Ex. 1016, (45).



Bayer's Figure 1A, above, shows sensor patterns 2, 4, and 6. *Id.* at 3:51–55. Figure 1B, above, shows those patterns interlaid to form image sampling array 8. *Id.* Each pattern corresponds to a color vector: *Y* for luminance and *C* for chrominance. *Id.* There are two chrominance patterns: *C*₁ and *C*₂. *Id.* at 3:62–66. The filter is superimposed on the sensor with a one-to-one correspondence to the sensor elements. *See id.* at 2:45–56, *cited in* Pet. 50. In a deposition, Dr. Sergienko, Patent Owner's declarant, acknowledged that Bayer's technology allows for simultaneous color sensing:

The pixel behind the red will detect only red color, the pixel behind the green will detect the green and behind the blue will detect the blue. It means your different parts of the sensor will give you information about different colors.

Ex. 1056, 63:8–13. Thus, from the passages cited in the Petition, Petitioner has sufficiently shown that Bayer teaches “simultaneous color sensing.” Pet. 50.

Considering the entirety of the record, we disagree with Patent Owner's argument that Petitioner has not explained how Bayer's filter array would

provide for “simultaneous color sensing.” PO Resp. 31 (citing Pet. 50). For the same reason, we assign little weight to the Sergienko Declaration on this issue. *See, e.g.*, Sergienko Decl. ¶ 66.

We also disagree with Patent Owner’s argument that Geng’s 2D scanning already provides simultaneous color scanning. PO Resp. 31 (citing Sergienko Decl. ¶ 66). Patent Owner has not, for example, shown that Geng requires a specific color sensor. *Id.* Rather, as Petitioner’s Reply points out, Geng teaches that “[t]he particular shape or configuration of CCD imaging device (120)” is not critical. Ex. 1014, 4:4–7, *cited in* Pet. Reply 4. Because the Sergienko Declaration is not consistent with the evidence of record on this issue, we assign it little weight. *See* Sergienko Decl. ¶ 66.

We also disagree with Patent Owner that Morgan’s limited bandwidth filter would render the combination non-obvious. PO Resp. 31; Sur-reply 7–8. Here, the claims do not recite a limited bandwidth filter, and the Petition does not map Morgan’s filter to any particular recited feature. *See* Pet; *accord* PO Resp. 8 (“The Petition is silent concerning Morgan’s limited bandwidth filter.”). Because Morgan merely proposes the filter as only “one way” of improving performance, Morgan does not indicate that Petitioner’s combination requires Morgan’s filter to meet any particular limitation. *See* Ex. 1011, 14:8–13. For at least these reasons, we disagree with Patent Owner’s argument about Morgan’s filter. PO Resp. 31; Sur-reply 7–8. For the same reasons, we accord Dr. Sergienko’s testimony little weight on this issue. *See* Ex. 1056, 53:5–56:2.

Even so, Patent Owner’s arguments and Dr. Sergienko’s testimony concerning a loss of resolution from using the Bayer filter are far too vague and lack the necessary support in the record. Sur-reply 7–8; Ex. 1056. For example, Dr. Sergienko testifies that Morgan’s pattern is incompatible with

Bayer. Ex. 1056, 54:16–56:2. Dr. Sergienko and Patent Owner characterize the loss of resolution that would result from combining Morgan and Bayer as “unacceptable.” *See, e.g.*, Sur-reply 8; Ex. 1056, 53:5–56:2. But, apart from these assertions, neither Patent Owner nor Dr. Sergienko provide, for example, sufficient metrics or benchmarks for assessing resolution. *See* PO Resp.; Sur-reply. Patent Owner and Dr. Sergienko also do not adequately address, for instance, whether the image sensor could be configured provide the desired resolution. *See* PO Resp.; Sur-reply. Thus, Patent Owner has not provided sufficient evidence to assess what the acceptable resolution would be under the circumstances. *See* Sur-reply 7–8.

Patent Owner further argues that Bayer does not disclose using its filter for 3D scanning. *Id.* at 8. We disagree with Patent Owner’s argument here (*id.*) and assign Dr. Sergienko’s testimony little weight on this issue (Ex. 1056, 54:16–56:2) because “[t]he question in an obviousness inquiry is . . . not whether each individual reference discloses all of the necessary elements.” *Game & Tech Co.*, 942 F.3d at 1352.

For the reasons discussed, we determine that Petitioner provides articulated reasoning, supported by rational underpinnings, why one of ordinary skill in the art would have combined Morgan, Geng, and Bayer. *See KSR*, 550 U.S. at 418. Based on Petitioner’s analysis, we find that a person of ordinary skill in the art would have combined Morgan, Geng, and Bayer to obtain the filter recited in claims 4, 5, and 9.

Thus, we determine that Petitioner has shown by a preponderance of the evidence that claims 4, 5, and 9 are unpatentable as obvious over Morgan, Geng, and Bayer. *See* Pet. 50–51.

E. Obviousness over Morgan, Geng, and Engelhardt

Petitioner asserts that claims 11 and 12 are unpatentable as obvious over Morgan, Geng, and Engelhardt. Pet. 51–53.

Claim 11 recites, “The intraoral scanner according to claim 10, wherein the lighting equipment, the color image sensor, and at least a portion of the data processing system are included in a handheld unit.” Ex. 1001, 38:20–23. Claim 12 depends from claim 11 and further recites, “wherein the intraoral scanner is configured to transmit data from the handheld unit to a separate workstation.” *Id.* at 38:24–26.

Petitioner asserts that Geng teaches a handheld unit with lighting equipment and a color image sensor. Pet. 51 (citing Ex. 1014, 3:55–58, Figs. 1–4). Petitioner asserts that Morgan teaches a single unit with a structured light source and an image source. *Id.* (citing Ex. 1011, Fig. 2).

Petitioner turns to Engelhardt for teachings related to a confocal device for measuring the tooth surfaces with a handheld intraoral-probe housing. *Id.* (citing Ex. 1045, 1:5–8, 4:60–61). According to Petitioner, Engelhardt’s device “includes a light source for illuminating the intraoral surface, a detector for imaging the surface, and a processor which digitizes the detected signal and processes it.” *Id.* (citing Ex. 1045, 1:5–11, 3:45–49). Petitioner explains that Engelhardt’s functional units are miniaturized and the resulting system is compact and needs only a connection to a power supply. *Id.* at 51–52 (citing Ex. 1045 5:62–6:3; Hesselink Decl. ¶ 219).

To address the workstation recited in claim 12, Petitioner asserts that Morgan teaches sending 2D contour maps and the 3D model to a computer monitor for display. *Id.* at 52 (citing Ex. 1011, 4:32–33, 6:63–66, 8:13–22, Figs. 2, 3). Petitioner also asserts that Geng teaches transmitting image data

to tool 220, which can be “rapid proto-typing, cutting or milling machinery.” *Id.* at 52–53 (citing Ex. 1014, 5:11–20, 5:34–42; Hesselink Decl. ¶ 221).

As for the obviousness rationale, Petitioner explains that a person of ordinary skill in the art “would have had reason to incorporate the lighting equipment, the color image sensor, and at least a portion of the data processing system into a handheld unit for intraoral scanning in a device like Morgan’s because doing so would provide a compact handheld system while reducing the number of connections needed to external components.” *Id.* at 52 (citing Hesselink Decl. ¶ 220). Petitioner asserts that there would have been a reasonable expectation of success because “Engelhardt teaches the components can be properly miniaturized while still retaining 3D confocal scanning capabilities.” *Id.*⁸

Patent Owner argues that “such a modification of incorporating additional components into the handheld unit would only serve to make Geng’s handheld unit heavier, bulkier, and less compact.” PO Resp. 32; *see also* Sur-reply 15 (discussing “added weight and bulk”). Patent Owner also argues that “Petitioner fails to demonstrate that reducing the number of connections would somehow have led a POSA to make Geng’s handheld unit heavier, bulkier, and less compact by incorporating additional on-board components.” PO Resp. 34; *see also* Sur-reply 15 (arguing Engelhardt a power-supply connection would still be needed).

⁸ Here, Engelhardt is the basis for Petitioner’s reasoning. Pet. 52. Petitioner also points to other sources. *See id.* (citing Ex. 1030, 62–64). Because Engelhardt is sufficient for the reasons discussed in this section, we need not consider those other sources in reaching our decision about the patentability of the claims.

Patent Owner's arguments (*id.*), though, assume that the components would be bodily incorporated into Engelhardt, which is not the test for obviousness. *See Keller*, 642 F.2d at 425. So we disagree with Patent Owner's arguments (PO Resp. 32–34) for reasons similar to those discussed in Section C.3.a). That is, even assuming that the variable focal length lens system were used in the proposed combination, the test for obviousness does not ask whether Morgan's variable focal length lens system could be incorporated in Geng's probe without further modification. *See supra* § C.3.a). Thus, we disagree with Patent Owner's arguments based on bodily incorporation of Morgan in Geng and Engelhardt, and assign little weight to the Sergienko Declaration on this issue. PO Resp. 32–34; Sergienko Decl. ¶¶ 68–71.

We also disagree with Patent Owner's argument that "Engelhardt does not demonstrate that Morgan's other components, e.g., projector lamp control unit 9 and piezo-electric grid control unit 10, would also have been miniaturized, and Petitioner makes no such assertion of miniaturizing and incorporating such components into Geng's handheld unit." PO Resp. 33. In particular, Engelhardt need not expressly disclose how to miniaturize each of Morgan's components because "[a] person of ordinary skill in the art is also a person of ordinary creativity, not an automaton." *KSR*, 550 U.S. at 421. One must account for "the inferences and creative steps that a person of ordinary skill in the art would employ." *Id.* at 418. Patent Owner's argument here does not. *See* PO Resp. 33.

Rather, Petitioner's obviousness rationale is adequately supported by Engelhardt's teachings about handheld-unit design. Ex. 1045, 5:52–6:3. For example, Engelhardt teaches several options including placing all the functional units in the handheld unit via miniaturization. *See id.* Petitioner

has shown that Engelhardt’s components are sufficiently similar to those in the Morgan and Geng units. *Compare id.*, with Ex. 1014, 3:55–58, Figs. 1–4, Ex. 1011, Fig. 2. For example, like Morgan’s, Engelhardt’s teachings are related to a confocal⁹ device. Ex. 1045, 1:5–8, 4:60–61, *cited in* Pet. 51; Ex. 1011, Abstract, 1:55–66, 4:43–52, 8:23–30 (describing a confocal device), *cited in* Pet. 11.

This evidence supports Dr. Hesselink’s testimony that “[t]he person of ordinary skill would have had a reasonable expectation of success because Engelhardt teaches that the processor can be properly miniaturized while still retaining 3D confocal scanning capabilities.” Hesselink Decl. ¶ 220. Thus, we credit the Hesselink Declaration on this point. *See id.* And we assign the Sergienko Declaration’s assertions to the contrary little weight on this issue. Sergienko Decl. ¶¶ 68–71.

For the reasons discussed, we determine that Petitioner provides articulated reasoning, supported by rational underpinnings, why one of ordinary skill in the art would have combined Morgan, Geng, and Engelhardt. *See KSR*, 550 U.S. at 418. Based on Petitioner’s analysis, we find that a person of ordinary skill in the art would have combined Morgan, Geng, and Engelhardt to obtain the recited device of claims 11 and 12.

Thus, we determine that Petitioner has shown by a preponderance of the evidence that claims 11 and 12 are unpatentable as obvious over Morgan, Geng, and Engelhardt. *See* Pet. 51–53.

⁹ As used in Morgan, the term “confocal” describes an optical system arranged so that two images formed by the system are in focus at the same time. Ex. 1011, 3:15–17.

F. Remaining Grounds

Petitioner presents cumulative challenges to claims 1–22 based on Noguchi, Bayer, and Engelhardt. Pet. 53–80.

Because we determine that claims 1–22 are unpatentable for the reasons discussed above, we do not separately assess the patentability of these claims based on the remaining grounds in this proceeding. *See SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1359 (2018) (holding that a petitioner “is entitled to a final written decision addressing all of the claims it has challenged”); *Boston Sci. Scimed, Inc. v. Cook Grp. Inc.*, 809 F. App’x 984, 990 (Fed. Cir. 2020) (non-precedential) (recognizing that the “Board need not address issues that are not necessary to the resolution of the proceeding” and, thus, agreeing that the Board has “discretion to decline to decide additional instituted grounds once the petitioner has prevailed on all its challenged claims”).

III. CONCLUSION

Petitioner has met its burden to show that claims 1–22 are unpatentable.¹⁰

¹⁰ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

Claim(s)	35 U.S.C. §	Reference(s)	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–3, 6–8, 10, 13–22	103(a)	Morgan, Geng	1–3, 6–8, 10, 13–22	
4, 5, 9	103(a)	Morgan, Geng, Bayer	4, 5, 9	
11, 12	103(a)	Morgan, Geng, Engelhardt	11, 12	
1–3, 6–8, 10, 13–22	103(a) ¹¹	Noguchi		
4, 5, 9	103(a) ¹²	Noguchi, Bayer		
11, 12	103(a) ¹³	Noguchi, Engelhardt		
Overall Outcome			1–22	

IV. ORDER

It is

ORDERED that claims 1–22 of the '042 patent are unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to this proceeding seeking judicial review of the Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

¹¹ We do not reach this ground. *See supra* § II.F.

¹² We do not reach this ground. *See supra* § II.F.

¹³ We do not reach this ground. *See supra* § II.F.

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