

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ALIGN TECHNOLOGY, INC.,
Petitioner,

v.

DENTAL MONITORING SAS,
Patent Owner.

IPR2024-00052
Patent No. 11,049,248

PATENT OWNER'S NOTICE OF APPEAL

Notice is hereby given pursuant to 35 U.S.C. §§ 141(c), 142, 319; 37 C.F.R. §§90.2(a), 90.3(a); and Federal Rules of Appellate Procedure/Federal Circuit Rule 4(3)(a), that Patent Owner Dental Monitoring SAS, Inc. (“Patent Owner”) hereby appeals to the United States Court of Appeals for the Federal Circuit from the Final Written Decision entered on April 16, 2025 (Paper 42) (the “Final Written Decision”), and from all underlying orders, decisions, rulings and opinions regarding U.S. Patent No. 11,049,248 (“the ’248 Patent”). The Final Written Decision is attached to this Notice as Exhibit A.

For the limited purpose of providing the Director with the information requested in 37 C.F.R. § 90.2(a)(3)(ii), Patent Owner expects that the issues on appeal may include the following, as well as any underlying findings, determinations (including claim constructions), rulings, decisions, opinions, or other related issues: whether the Board erred in finding that claims 1, 2, 4, 7, 8, and 13-16 of the ’248 Patent are unpatentable under 35 U.S.C. § 103 over the combination of Kim, Invisalign, Salah, and Maninis; and whether the Board erred in denying Patent Owner’s motion to exclude certain evidence.

Copies of this Notice of Appeal are being filed simultaneously with the Director, the Patent Trial and Appeal Board, and the Clerk of the United States Court of Appeals for the Federal Circuit, along with the required docketing fee.

DATED: June 18, 2025

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CERTIFICATE OF FILING

The undersigned hereby certifies that, in addition to being electronically filed through the PTAB's P-TACTS System, a true and correct copy of the above-captioned PATENT OWNER'S NOTICE OF APPEAL is being sent via email on June 18, 2025, to the Director of the United States Patent and Trademark Office, at the following address: efileSO@uspto.gov.

The undersigned also hereby certifies that a true and correct copy of the above-captioned PATENT OWNER'S NOTICE OF APPEAL and the filing fee is being filed via CM/ECF with the Clerk's Office of the United States Court of Appeals for the Federal Circuit on June 18, 2025.

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e), the undersigned certifies service of
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EXHIBIT A

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ALIGN TECHNOLOGY, INC.,
Petitioner,

v.

DENTAL MONITORING SAS,
Patent Owner.

IPR2024-00052
Patent 11,049,248 B2

Before JEAN R. HOMERE, MICHAEL R. ZECHER, and
KARA L. SZPONDOWSKI, *Administrative Patent Judges*.

SZPONDOWSKI, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)
Denying Patent Owner's Motion to Exclude
37 C.F.R. § 42.64(c)

I. INTRODUCTION

We instituted an *inter partes* review of claims 1, 2, 4, 7, 8, and 13–16 of U.S. Patent No. 11,049,248 B2, issued on June 29, 2021 (Ex. 1001, “the ’248 patent”), in response to a Petition (Paper 2, “Pet.”) filed by Align Technology, Inc. (“Petitioner”). Paper 10 (“Dec.”). During trial, Dental Monitoring SAS (“Patent Owner”) filed a Response to the Petition (Paper 20,¹ “PO Resp.”), Petitioner filed a Reply (Paper 25, “Reply”), and Patent Owner filed a Sur-reply (Paper 30, “Sur-reply”). In addition, Patent Owner filed a Motion to Exclude (Paper 34, “PO Mot. Excl.”), Petitioner filed an Opposition (Paper 35, “Pet. Opp. Mot. Excl.”), and Patent Owner filed a Reply (Paper 37, “PO Reply Opp. Mot. Excl.”).

We held a consolidated oral hearing in this proceeding and related IPR2024-00110 on January 29, 2025, and a copy of the transcript is entered into the record. Paper 41 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6 (2018). This Decision is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of the claims on which we instituted trial. Petitioner has the burden of proving unpatentability of a claim by a preponderance of the evidence. 35 U.S.C. § 316(e).

Based on the complete record, Petitioner has shown, by a preponderance of the evidence, that claims 1, 2, 4, 7, 8, and 13–16 of the ’248 patent are unpatentable.

We also *deny* Patent Owner’s Motion to Exclude.

¹ Patent Owner filed two copies of the Patent Owner Response, as Papers 20 and 21. We cite to Paper 20 herein.

II. BACKGROUND

A. *Real Parties-in-Interest*

Petitioner identifies itself as the real party-in-interest. Pet. 63. Patent Owner identifies itself as the real party-in-interest. Paper 4, 1 (Mandatory Notices of Patent Owner).

B. *Related Matter*

Petitioner and Patent Owner identify *Dental Monitoring SAS v. Align Technology, Inc.*, No. 3:22-cv-07335-WHA (N.D. Cal.) as a related matter. Pet. 63; Paper 4, 1.

C. *The '248 Patent (Ex. 1001)*

The '248 patent was filed as U.S. Patent Application No. 16/030,137 on July 9, 2018, and claims priority to French Patent Application No. 1756956, which was filed on July 21, 2017. Ex. 1001, codes (21), (22), (30).

The '248 patent is titled “Method for Analyzing an Image of a Dental Arch” and describes, among other things, “[a] method for assessing the shape of an orthodontic aligner.” Ex. 1001, codes (54), (57). In particular, the orthodontist determines the positioning of the teeth that he or she wants to obtain, and has manufactured an orthodontic appliance suited for this treatment, such as an orthodontic aligner. *Id.* at 27:26–34. The '248 patent describes that, conventionally, an aligner is in the form of a removable monobloc appliance made of a transparent polymer, that comprises a tray shaped in such a way to house teeth. *Id.* at 27:35–39. The shape of the aligner is “adapted to hold the aligner in position on the teeth, while exerting an action of correction on the positioning of certain teeth.” *Id.* at 27:40–42.

Conventionally, the shapes that different aligners take during treatment are determined and manufactured at the start of treatment, and the patient changes the aligner at predetermined times. *Id.* at 27:48–52. The patient visits the orthodontist at regular intervals for a visual inspection, so that the orthodontist can determine whether the aligner being worn by the patient is still suited to the treatment. *Id.* at 27:55–69.

The invention described in the '248 patent “considerably simplifies the assessment of the good suitability of the aligner to the treatment,” in particular, “the method may be implemented from simple photographs or films, taken with no particular precautions, for example by the patient,” thereby limiting the number of appointments with the orthodontist. Ex. 1001, 28:35–42. Specifically, a method is proposed “for analyzing an image called ‘analysis image’, of a dental arch of a patient, a method in which the analysis image is submitted to a deep learning device, preferably a neural network, in order to determine at least one value of a tooth attribute relating to a tooth represented on the analysis image, and/or at least one value of an image attribute relating to the analysis image.” *Id.* at 1:22–29.

The “analysis image” is “an image representing the aligner worn by the teeth of the patient” and is preferably captured by the patient on a cellphone. Ex. 1001, 8:43–53, 8:66–67, 30:16–18, 30:31–32. The “analysis image” may be taken “when the assessment of the shape of an aligner is desired, for example, more than 1 week after the start of the treatment with the aligner,” and preferably, at least one reminder is sent to the patient to capture the “analysis image.” *Id.* at 30:19–30.

The “analysis image” is submitted to and analyzed by a “deep learning device,” preferably a neural network, that was trained on a specific dataset, called a “learning base.” Ex. 1001, 1:39–43, 1:66–2:1, 16:5–6, 16:44–45, 24:3–5. According to the ’248 patent, the neural network may be chosen from networks specializing in the classification of images called CNN (“convolutional neural network”), for example, Microsoft ResNet or VGG Net. *Id.* at 16:7–25. “By presenting, as input for the deep learning device, historical images (images+descriptions), the deep learning device progressively learns to recognize patterns on an image, and to associate them with tooth zones and with tooth attribute values, for example tooth numbers.” *Id.* at 16:38–43. The deep learning device, therefore, analyzes the “analysis image” and is capable of recognizing patterns therein. *Id.* at 16:46–49. The tooth attribute may be related to separation, such as the separation between the tooth and an aligner worn by the tooth. *Id.* at 28:43–67, 30:35–41. “The value for this tooth attribute therefore provides an information item relating to the shape of the aligner relative to the shape of the teeth of the patient.” *Id.* at 30:42–44. Based upon this information, an assessment can be made as to the suitability of the aligner. *Id.* at 30:54–31:3.

D. *Illustrative Claims*

Among the challenged claims, claims 1 and 15 are independent. Independent claim 1, reproduced below, is illustrative of the claimed subject matter:

1. A method for assessing the shape of an orthodontic aligner, said method comprising the following steps:

a") more than 1 week after the start of the treatment with the aligner, acquisition of at least one image at least partially representing the aligner in a service position in which it is worn by a patient, called "analysis image", the analysis image being a photograph, or an image extracted from a film;

b") analysis of the analysis image by means of a deep learning device, trained by means of a learning base, so as to determine a value

for at least one tooth attribute of an "analysis tooth zone" representing, at least partially, a tooth on said analysis image, the tooth attribute relating to a separation between the tooth represented by the analysis tooth zone, and the aligner represented on the analysis image,

in the step a"), a cellphone is used to acquire the analysis image.

Ex. 1001, 32:6–23. Independent claim 15 recites similar limitations, but recites an "image attribute" rather than a "tooth attribute." *Id.* at 34:43–57.

Dependent claim 7 recites:

7. The method as claimed in claim 1, in which the step b") comprises the following steps:

1) creation of a learning base comprising more than 1000 images of dental arches, or "historical images", each historical image representing an aligner worn by a "historical" patient and comprising one or more zones each representing a tooth, or "historical tooth zones", to each of which, for at least one tooth attribute relating to a separation between the tooth represented by the historical tooth zone considered, and the aligner represented, a tooth attribute value is assigned;

2) training of at least one deep learning device, by means of the learning base;

3) submission of the analysis image to the deep learning device for it to determine at least one probability relating to:

the presence, in a location of said analysis image, of an analysis tooth zone, and

the attribute value of the tooth represented on said analysis tooth zone;

4) determination, as a function of said probability, of the presence of a separation of the aligner and of the tooth represented by said analysis tooth zone.

Ex. 1001, 32:45–67. Dependent claim 14 also depends from claim 1 and recites similar limitations. *Id.* at 34:21–42. Dependent claim 8 also depends from claim 1, and recites similar limitations as dependent claim 7, but recites an “image attribute” or “image attribute value” rather than a “tooth attribute” or “tooth attribute value.” *Id.* at 33:1–15.

E. Prior Art and Asserted Challenge to Patentability

Petitioner asserts that claims 1, 2, 4, 7, 8, and 13–16 are unpatentable based on the following challenge (Pet. 14):

Claims Challenged	35 U.S.C. § ²	References/Basis
1, 2, 4, 7, 8, 13–16	103	Kim, ³ Invisalign, ⁴ Salah, ⁵ Maninis ⁶

In support of its proposed challenge, Petitioner relies on the Declarations of Hassan Foroosh, Ph.D (Exs. 1002, 1029, 1048), Declaration of Nathaniel E. Frank-White (Ex. 1010), Declaration of Mitra Derakhshan (Ex. 1011), and Third and Fourth Affidavits of Nathaniel E. Frank-Wright (Exs. 1031, 1032). Patent Owner relies on the Declaration of John Mongan, M.D., Ph.D (Ex. 2028) and Declaration of Budi Kusnoto, D.D.S., M.S. (Ex. 2030). Deposition transcripts have been submitted to the record for Dr. Foroosh (Exs. 2048, 2054, 2065), Dr. Mongan (Exs. 1037, 1051), and Dr. Kusnoto (Exs. 1038, 1052).

² Because the '248 patent issued from a patent application that was filed after March 16, 2013 (Ex. 1001, codes (21), (22)), patentability is governed by the version of 35 U.S.C. § 103 as amended by the Leahy-Smith America Invents Act ("AIA"), Pub L. No. 112–29, 125 Stat. 284 (2011).

³ Kim, US 2017/0281313 A1, published Oct. 5, 2017 ("Kim," Ex. 1005). Petitioner contends that Kim is prior art to the '248 patent under 35 U.S.C. § 102(a)(2). Pet. 6.

⁴ *Invisalign Clinical Monitoring Guide*, Align Technology, Inc. (2003) ("Invisalign," Ex. 1006). Petitioner contends that Invisalign is prior art to the '248 patent under 35 U.S.C. § 102(a)(1). Pet. 8.

⁵ Salah et al., WO 2016/066651 A1, published May 6, 2016 ("Salah," Ex. 1008). Petitioner contends that Salah is prior art to the '248 patent under 35 U.S.C. § 102(a)(1). Pet. 9.

⁶ Maninis et al., *Convolutional Oriented Boundaries: From Image Segmentation to High-Level Tasks*, arXiv.org, published no later than May 2, 2017 ("Maninis," Ex. 1007). Petitioner contends that Maninis is prior art to the '248 patent under 35 U.S.C. § 102(a)(1). Pet. 10.

III. ANALYSIS

A. *Legal Standards*

A claim is unpatentable under 35 U.S.C. § 103 if “the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains.” The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) when in evidence, objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

A patent claim “is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). An obviousness determination based on a combination of references requires finding “both ‘that a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so.’” *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367–68 (Fed. Cir. 2016) (citation omitted); *see KSR*, 550 U.S. at 418. Further, an assertion of obviousness “cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *KSR*, 550 U.S. at 418; *In re NuVasive, Inc.*, 842 F.3d 1376,

1383 (Fed. Cir. 2016) (a finding of a motivation to combine “must be supported by a ‘reasoned explanation’” (citation omitted)).

In an *inter partes* review, a petitioner bears the burden of persuasion to prove “unpatentability by a preponderance of the evidence.” *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (quoting 35 U.S.C. § 316(e)). This burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware*, 800 F.3d at 1378 (citing *Tech. Licensing Corp. v. Videotek, Inc.*, 545 F.3d 1316, 1326–1327 (Fed. Cir. 2008)). Petitioner must explain with particularity how the prior art would have rendered the challenged claims unpatentable. 35 U.S.C. § 312(a)(3); 37 C.F.R. § 42.104(b)(4) (2024) (“The petition must specify where each element of the claim is found in the prior art patents or printed publications relied upon.”).

B. *Level of Ordinary Skill in the Art*

Determining whether an invention would have been obvious under 35 U.S.C. § 103 requires resolving the level of ordinary skill in the pertinent art at the time of the effective filing date of the claimed invention. *Graham*, 383 U.S. at 17. The person of ordinary skill in the art is a hypothetical person who knows the relevant art. *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995). Factors that may be considered in determining level of ordinary skill in the art include (1) the educational level of the inventor; (2) the types of problems encountered in the art; (3) prior art solutions to those problems; (4) the rapidity with which innovations are made; (5) the sophistication of the technology; and (6) the educational level of active

workers in the field. *Daiichi Sankyo Co. v. Apotex, Inc.*, 501 F.3d 1254, 1256 (Fed. Cir. 2007).

Petitioner contends that a person of ordinary skill in the art “would typically have an advanced degree, such as a Masters’ Degree or Ph.D. in computer science, computer engineering, electrical engineering, or a related field, with at least two years of work in computer vision, image analysis, medical imaging, or related areas.” Pet. 14 (citing Ex. 1002 ¶¶ 60–61). Petitioner further contends that a person of ordinary skill in the art “could have less education but significant professional experience in one or more of these fields” and “could be a member of an interdisciplinary team.” *Id.*

Patent Owner offers a slightly different definition of the level of ordinary skill in the art. PO Resp. 3–4; Sur-reply 2. Patent Owner contends that a person of ordinary skill in the art:

would have had a bachelor’s degree or higher in computer science, bioinformatics, or a related engineering discipline, and several years of work experience relating to the development of machine learning or artificial intelligence models or algorithms. A [person of ordinary skill in the art] **would** have also worked as part of a multi-disciplinary team, which **would have included individuals familiar with medical imaging, dental imaging, dentistry, and/or orthodontics.**

PO Resp. 3–4 (quoting Ex. 2028 ¶ 47–50; citing Ex. 2028 ¶¶ 54–57, Ex. 2030 ¶¶ 27–30) (emphasis in original). Patent Owner argues that “the relevant field is aligner treatment.” *Id.* at 4 (citing Ex. 2030 ¶ 57). According to Patent Owner, it would have been necessary for a POSITA to consult with an individual having experience in dentistry and/or orthodontics

in order to understand Invisalign, Kim, and Salah. *Id.* (citing Ex. 2030 ¶¶ 56–57; Ex. 2028 ¶ 50); Sur-reply 2.

The parties agree that the proposed levels of ordinary skill in the art are “not materially different.” PO Resp. 4; Reply 2. The difference, essentially, is that Patent Owner more explicitly describes the members on the interdisciplinary team, and argues that it would be necessary to consult with such individuals, particularly with persons experienced in dentistry or orthodontics, whereas Petitioner’s proposal states that one “could” consult with such individuals. However, Patent Owner’s argument that it would be necessary for a person of ordinary skill in the art to consult with an individual having experience in dentistry and/or orthodontics is narrower than Patent Owner’s proposed level of skill in the art, which describes “individuals familiar with medical imaging, dental imaging, dentistry, and/or orthodontics.” PO Resp. 3 (emphasis omitted, emphasis added). Neither party presents any argument explaining how the differences in the respective educational backgrounds and work experience in the proposed definitions affect the dispute.

Having considered the parties’ respective arguments and the evidence of record, we adopt a modified version of the parties’ proposals, and determine for purposes of this Decision that a person of ordinary skill in the art would have an advanced degree, such as a Masters’ Degree or Ph.D. in computer science, computer engineering, electrical engineering, or a related field, with at least two years of work in computer vision, image analysis, medical imaging, or related areas. Further, a person of ordinary skill in the art could have less education but significant professional experience in one

or more of these fields, and could be a member of an interdisciplinary team which would have included individuals familiar with medical imaging, dental imaging, dentistry, and/or orthodontics.

Patent Owner argues that Dr. Foroosh is not qualified to testify as a person of ordinary skill in the art and, therefore, his testimony should be given no weight. PO Resp. 5; Sur-reply 2–4 (citing *Kyocera Senco Indus. Tools Inc. v. Int’l Trade Comm’n*, 22 F.4th 1369, 1376–77 (Fed. Cir. 2022)). Several of Patent Owner’s arguments rest on Dr. Foroosh’s alleged lack of qualifications. *See, e.g.*, PO Resp. 47–54. Patent Owner asserts that Dr. Foroosh “has no training or experience with dentistry or orthodontics, and did not consult with such a person to form his opinions.” *Id.* at 5 (citing Ex. 2048, 11:9–12, 12:19–22, 13:12–23; Ex. 2054, 124:16–19)). According to Patent Owner, this lack of relevant experience caused Dr. Foroosh to “misinterpret or ignore portions of” the prior art. *Id.*; *see also id.* at 49–51 (arguing Dr. Foroosh was “unable to understand key portions of Invisalign or explain the meaning of terms appearing on the same pages of Invisalign that he cites”). For example, Patent Owner asserts that Dr. Foroosh testified that he had “no idea” whether the photograph in Invisalign’s Figure A is a common position for an aligner, and “could not say how an orthodontist allegedly assessed aligner fit in 2017.” *Id.* at 5 (citing Ex. 2054, 60:18–61:4, 45:17–19, 74:9–14, 42:4–7, 58:24–59:5, 65:12–13) (emphasis omitted); *see also id.* at 49–50 (arguing the same).

We are satisfied that Dr. Foroosh qualifies as a person of ordinary skill in the art. First, Dr. Foroosh has the required educational background, with, for example, a Bachelor of Science in Electrical Engineering, a Master

of Science in Electrical Engineering, a Master of Science in Computer Science and Engineering, and a Ph.D in Computer Science. Ex. 1003, 7; Ex. 1002 ¶ 3. Second, Dr. Foroosh has the required work experience, with, for example, research in machine learning, deep learning, and neural networks, image and video processing and analysis, and computer vision. Ex. 1003, 2, 4–8; *see also id.* at 9–13 (list of projects), 14–29 (list of publications), 32 (list of interdisciplinary research); Ex. 1002 ¶¶ 2–5 (describing work experience), 6–9 (describing research experience).

Dr. Foroosh has also been part of interdisciplinary research efforts including those relating to the medical or dental fields, such as, research on the intersection of computer vision and augmented reality in medical and surgical interventions. Ex. 1003, 32; Ex. 1002 ¶ 12. Dr. Foroosh describes a research project, *Modeling and Visualization of Musculoskeletal Structures in Dental CT-Scan* (2006–2007), where he “developed algorithms for [three-dimensional (‘3D’)] registration, modeling and visualization of maxilla and mandible of patients for dental surgery using Computer Aided Tomography (CAT) scanning.” Ex. 1002 ¶ 6. He describes another project for the National Science Foundation, which “was directed to the registration/alignment of dental CT scans of patients over a period of time during the treatment of a patient, with the purpose of improving the quality of 3D models, e.g., corrections and noise removal in 3D CT scans.” *Id.* ¶ 7. He was also a co-author on *Alignment of Maxillofacial CT Scans to Stone-Cast Models Using 3D Symmetry for Backscattering Artifact Reduction*, Proceedings of Medical Image Understanding and Analysis Conference (MIUA) (2006), and an adviser for a dissertation directed to “*Sub-pixel*

Registration in Computational Imaging and Applications to Enhancement of Maxillofacial CT Data,” which “focused on registration and alignment of 2D images and 3D digitized data obtained by dental CT scans and dental imprints of a patient.” *Id.* ¶¶ 8, 9. Although Dr. Foroosh is not a dentist or orthodontist, we determine that the breadth of his background, as fully set forth in Exhibit 1003, qualifies him to provide testimony from the perspective of a person of ordinary skill in the art. In short, we agree with Petitioner that Dr. Foroosh has “ample experience with medical and dental imaging,” as set forth above. Reply 2 (citing Ex. 1002 ¶¶ 6–9; Ex. 1003, 14, 15, 21, 26, 32).

Moreover, we are afforded broad discretion in assigning weight that is to be accorded expert testimony. *See Yorkey v. Diab*, 601 F.3d 1279, 1284 (Fed. Cir. 2010) (“[T]he Board was well within its discretion to give more credibility to [one expert over another] unless no reasonable trier of fact could have done so.”); *see also* CTPG⁷ 34–36. In the analysis that follows, when applicable, we weigh the credibility of Dr. Foroosh’s testimony, including with respect to Patent Owner’s arguments regarding Dr. Foroosh’s testimony on the Invisalign reference, and provide our reasons therefore.

C. Claim Construction

In an *inter partes* review, we apply the same claim construction standard as would be used by a district court to construe a claim in a civil action involving the validity or infringement of a patent. 37 C.F.R.

⁷ Patent Trial and Appeal Board Consolidated Trial Practice Guide (CTPG) (Nov. 2019) (*available at* <https://www.uspto.gov/sites/default/files/documents/tpgnov.pdf?MURL=Tri alPracticeGuideConsolidated>).

§ 42.100(b). Under that standard, claim terms are generally given their ordinary and customary meaning, as would have been understood by one with ordinary skill in the art, in the context of the intrinsic record including the specification, the prosecution history, and other claims, and extrinsic evidence including expert and inventor testimony, dictionaries, and learned treatises. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–17 (Fed. Cir. 2005) (en banc). Only those claim terms that are in controversy need to be construed, and only to the extent necessary to resolve the controversy. *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

Petitioner provides constructions for the term “tooth attribute,” as recited in claim 1, the term “image attribute,” as recited in claims 8 and 15, and the term “image extracted from a film,” as recited in claims 1 and 15. Pet. 15–18. In addition, Petitioner contends that the second step of claims 1 and 15 (i.e., steps 1(b") and 15(b"))), whether construed as a means-plus-function limitation or not, does not distinguish over the prior art. *Id.* at 19. However, Petitioner identifies the corresponding function as “analyzing an image” and the structure “to encompass a device comprising a deep learning neural network trained with a learning base.” *Id.* at 19–20.

Patent Owner responds to Petitioner’s proposed constructions for “tooth attribute” and “image attribute,” and further provides constructions for the terms “deep learning device,” as recited in claims 1, 7, 8, and 13–16,

and “shape of an orthodontic aligner,” as recited in claims 1 and 15. PO Resp. 13–16. We address the parties’ contentions below.

1. Tooth attribute

Petitioner contends that “tooth attribute,” as recited in claim 1, “includes any attribute related to a tooth.” Pet. 15 (citing Ex. 1002 ¶¶ 62–64). Petitioner further contends that the “tooth attribute” “includes any attribute of a tooth that may relate to the tooth’s separation from an aligner, including attributes specific to the tooth or to the aligner, such as their respective positions or edges, which may bear a relation to the separation between the tooth and the aligner.” *Id.* at 16 (citing Ex. 1002 ¶ 65).

Patent Owner argues that “Petitioner’s construction is overbroad and should be rejected.” PO Resp. 13 (citing Ex. 20[30] ¶¶ 143–149; Ex. 1001, 28:62–29:13). According to Patent Owner, the ’248 patent distinguishes between a “tooth zone,” which corresponds to the “zone” or “location” of a tooth in the analysis image, and a “tooth attribute,” which is an “‘attribute’ of the tooth.” *Id.* at 13–14 (citing Ex. 20[30] ¶¶ 144–145); *see also id.* at 14 (arguing “tooth attribute” should be construed as “attribute of a tooth”).

We agree with the parties that a “tooth attribute” is an “attribute of a tooth.” Petitioner’s proposed construction goes further, and provides examples of what a “tooth attribute” may include. However, the relevant claim language of claim 1 recites a “tooth attribute relating to a separation between the tooth represented by the analysis tooth zone, and the aligner represented on the analysis image.” Ex. 1001, 32:19–21. In light of the plain language of the claim, and based on the record before us, we determine that no further construction of “tooth attribute” is necessary for purposes of

this Decision. We further discuss the “tooth attribute” below in connection with our analysis of dependent claims 7 and 14.

2. Image attribute

Petitioner contends that an “image attribute,” as recited in claims 8 and 15 “includes an attribute having a value (which may be a set of values for multiple teeth) relating to an image as a whole.” Pet. 16 (citing Ex. 1002 ¶ 66). Petitioner further contends that an “image attribute” “includes any attribute of the image as a whole that relates to the separation between one or more teeth and the aligner,” such as, for example, “an indication of whether an aligner or gap was present in the image, a measure of individual or average separation[,] an indication of whether the overall separation is acceptable, or a measure of another value that may be used to assess separation of teeth from the aligner.” *Id.* at 17 (citing Ex. 1002 ¶ 67).

Patent Owner agrees that the “image attribute” relates to the “image as a whole” and may be “a function of the tooth attribute values,” but disagrees to the extent that Petitioner’s construction includes its “overbroad construction” of “tooth attribute.” PO Resp. 15.

We agree with the parties that the “image attribute” relates to the “image as a whole.” However, again, Petitioner’s proposed construction provides examples of what the image attribute may include. Claim 8 recites that “the image attribute” may relate “to a separation between the tooth or teeth and the aligner represented on the historical image.” Ex. 1001, 33:6–9. Similarly, claim 15 recites that “the image attribute” may relate “to a separation between at least one tooth represented on the analysis image, and the aligner represented on said analysis image.” *Id.* at 34:54–57. In light of

the plain language of these claims, and based on the record before us, we determine that no further construction of “image attribute” is necessary for purposes of this Decision. We further discuss the “image attribute” below in connection with our analysis of dependent claim 8.

3. Image extracted from a film

Petitioner contends that “image extracted from a film,” as recited in claims 1 and 15, “should be interpreted to refer to an image extracted from a video recording.” Pet. 18 (citing Ex. 1002 ¶ 68).

Patent Owner does not respond to Petitioner’s proposed construction. *See generally* PO Resp. As there is no dispute between the parties, and after reviewing the record, we determine that express construction of “image extracted from a film” is not necessary for purposes of this Decision. As set forth below, Petitioner’s contentions rely on the alternative, “the analysis image being a photograph.”

4. Deep learning device

Patent Owner contends that a person of ordinary skill in the art would have understood a deep learning device in the context of the ’248 patent is “a device that, through training, is capable of analyzing an image and recognizing patterns therein.” PO Resp. 15 (citing Ex. 1001, 16:46–48, 17:30–32, 24:26–48; Ex. 2028 ¶¶ 153–156; Ex. 2054, 169:22–171:11).

Petitioner argues that Patent Owner’s construction “does not distinguish over the combination proposed in the [P]etition,” so the claims are “unpatentable regardless of Patent Owner’s construction.” Reply 5.

As there is no dispute between the parties, and after reviewing the record, we determine that express construction of “deep learning device” is not necessary for purposes of this Decision.

5. *Shape of an orthodontic aligner*

Patent Owner contends that, to the extent the preambles of claims 1 and 15 are limiting, the “shape of an orthodontic aligner” should be construed to mean “the shape of the aligner relative to the shape of the teeth of the patient.” PO Resp. 16 (citing Ex. 2028 ¶¶ 157–160).

Petitioner argues that Patent Owner does not argue that the preambles are limiting and “makes no arguments relying on its construction,” so the claims are “unpatentable regardless of Patent Owner’s construction.” Reply 5.

As there is no dispute between the parties, and after reviewing the record, we determine that express construction of “shape of an orthodontic aligner” is not necessary for purposes of this Decision.

D. *Alleged Obviousness Over Kim, Invisalign, Salah, and Maninis*

Petitioner contends claims 1, 2, 4, 7, 8, and 13–16 would have been obvious over the combination of Kim, Invisalign, Salah, and Maninis. Pet. 20–59. Patent Owner disputes Petitioner’s contentions. PO Resp. 42–70. We first provide overviews of Kim, Invisalign, Salah, and Maninis, and then we address the parties’ arguments.

1. *Kim (Ex. 1005)*

Kim is titled “Method and System for Providing Remote Teeth Alignment Services and Computer-Readable Medium on Which the Method is Recorded,” and is generally directed to “a method and system for

providing remote teeth alignment services to remotely advise an appropriate step of a clear aligner using a smartphone of an orthodontic patient, and a computer-readable medium on which the method is recorded.” Ex. 1005, code (54), ¶ 1.

In particular, Kim describes:

a method and system for providing remote teeth alignment services, by which an orthodontist may obtain accurate teeth alignment information using a device, e.g., a smartphone, of an orthodontic patient, may remotely and accurately diagnose the condition of the patient based on the teeth alignment information, and may remotely provide information about an accurate step of a clear aligner to be currently worn by the orthodontic patient, thereby greatly reducing a diagnosis time and cost of the orthodontic patient and the orthodontist, the accuracy of diagnosis may be improved by automatically obtaining photos of accurate sizes and locations using various virtual lines, the teeth alignment information may be easily used by the orthodontist by providing the teeth alignment information in the form of report information and classifying the teeth alignment information based on time, teeth alignment may be precisely performed in a customized manner by providing manufacturing information to a clear aligner manufacturer when an additional or modified clear aligner is necessary, interest of orthodontic patients may be increased by disclosing the teeth alignment information of a selected orthodontic patient, and the orthodontic patients may be inspired with a greater desire for aligned teeth by providing benefits to the selected orthodontic patient, and a computer-readable medium having recorded the method thereon.

Ex. 1005 ¶ 10. Figure 1, which depicts “a conceptual view of a system for providing remote teeth alignment services,” (*id.* ¶ 26) is reproduced below:

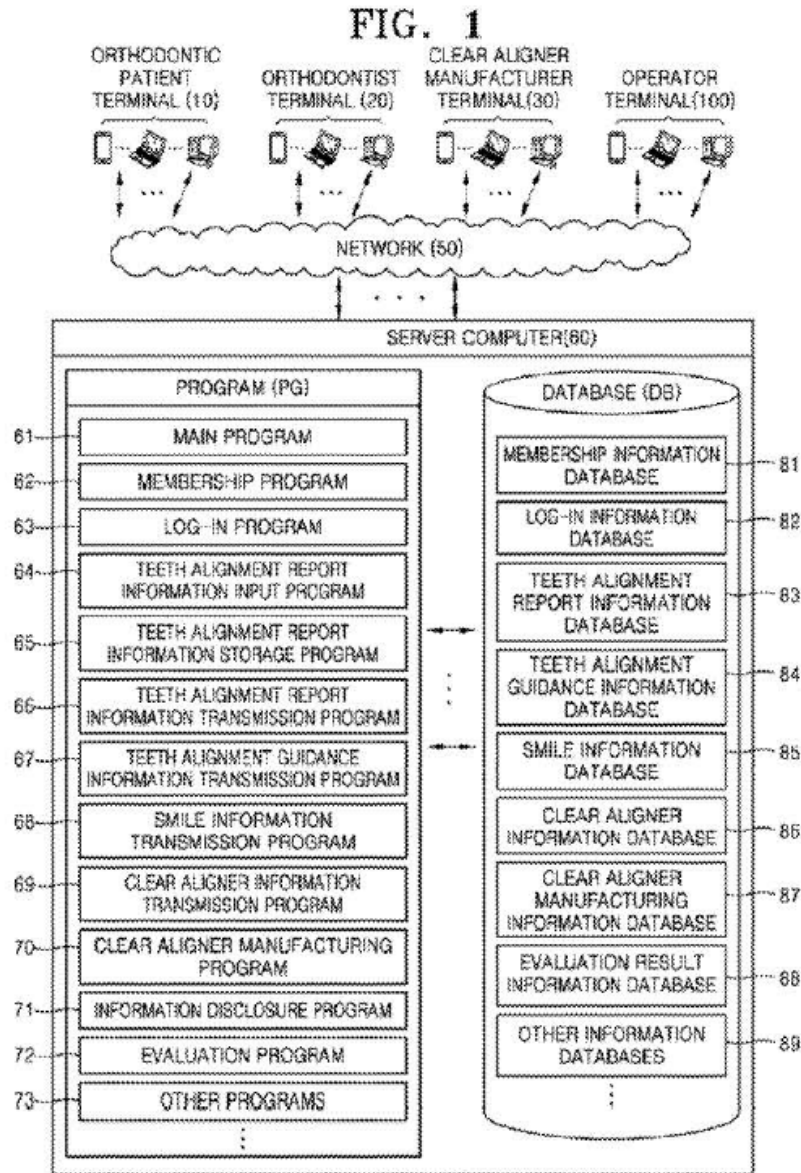


Figure 1, shows, among other things, orthodontic patient terminal 10, orthodontist terminal 20, clear aligner manufacturer terminal 30, operator terminal 100, and server computer 60, all interconnected through network 50. Ex. 1005 ¶¶ 39, 49, Fig. 1. Orthodontic patient terminal 10 may be, for example, a smartphone or mobile device. *Id.* ¶ 42. Orthodontist terminal 20 may, likewise, be a smartphone or mobile device. *Id.* ¶ 44.

According to Kim, the patient may provide “teeth alignment information” to orthodontist terminal 20 by taking a variety of photographs of the patient’s teeth from different angles using orthodontic patient terminal 10. Ex. 1005 ¶¶ 10, 42, 55, 56, 60 80. Orthodontic patient terminal 10 may send “clear aligner information about a currently worn clear aligner” to orthodontist terminal 20, so that “the orthodontist checks a photo or a video of the clear aligner currently worn by the orthodontic patient, and determines whether the clear aligner is normal and corresponds to an appropriate step.” *Id.* ¶ 66; *see also id.* ¶ 10.

2. *Invisalign (Ex. 1006)*

Invisalign is “intended to help the Invisalign practitioner successfully monitor Invisalign treatments and address issues that may arise between receipt of Aligners from Align to the completion of treatment.” Ex. 1006, i. Invisalign provides guidance to monitor treatment progress of patients after aligners have been received and are being worn by the patient. *Id.* at i–iv. For example, the practitioner can “evaluate any fit concerns that may arise” by “[h]av[ing] patients arrive with the previous stage Aligner and the current Aligner.” *Id.* at ii. Invisalign includes information on “Managing Aligner fit and seating,” and advises that an “Aligner [is] seating poorly” if there is greater than 1 mm gap between the teeth and aligner. *Id.* at 1. Invisalign further states that “Aligners should be fitting well at the end of the 2-week period.” *Id.*

3. *Salah (Ex. 1008)*

Salah is titled “Method for Monitoring Dentition,” and is generally directed to “monitoring . . . the appearance of the teeth of a patient.”

Ex. 1008, codes (54), (57). Salah generally describes methods for monitoring the positioning, shape, and/or appearance of a patient's teeth by obtaining two-dimensional ("2D") images of a patient's teeth and comparing them to a 3D digital reference model. *Id.* at 1:1–2:19.

Salah's method starts with the creation of a 3D "initial reference model" of the patient's dental arch, then a 2D "updated image" is acquired and analyzed to assess tooth deformation and/or displacement since the "initial reference model," and then the "initial reference model" is modified until a "final reference model" is obtained that corresponds to the updated image. Ex. 1008, 1:28–2:19.

Salah describes that the "updated image" may be a "photograph taken by the patient." Ex. 1008, 2:24, 31:5–7 ("image acquisition can be carried out by the patient himself or by one of their relatives, using a simple cell phone, anywhere, and especially outside a medical, dental or orthodontic practice"); *see also id.* at 27:11–13. In order to compare the updated and reference images, Salah describes comparing discriminant information on both images. *Id.* at 40:19–20. "Discriminant information is preferably chosen from the group consisting of *contour information*, color information, density information, a distance information, brightness information, saturation information, reflection information and combinations of these." *Id.* at 34:8–10 (emphasis added). Salah discloses various methods for processing an image to obtain discriminant information, including deep learning. *Id.* at 34:11–36:14.

4. *Maninis (Ex. 1007)*

a) *Description of Maninis*

Maninis is titled “Convolutional Oriented Boundaries: From Image Segmentation to High-Level Tasks.” Ex. 1007, 1. Maninis “present[s] Convolutional Oriented Boundaries (COB), which produces multiscale oriented contours and region hierarchies starting from generic image classification Convolutional Neural Networks (CNNs).” *Id.* (Abstract). Maninis “also evaluate[s] COB on high-level tasks when coupled with multiple pipelines for object proposals, semantic contours, semantic segmentation, and object detection.” *Id.*; *see also id.* at 11–12.

Maninis states that the “latest wave of contour detectors takes advantage of deep learning to obtain state-of-the-art results,” and provides “an end-to-end deep framework to boost the efficiency and accuracy of contour detection, using convolutional feature maps and a novel loss function.” Ex. 1007, 2. Figure 2 of Maninis, reproduced below, further illustrates using a deep learning device for performing contour and edge detection in images. *Id.* at 3.

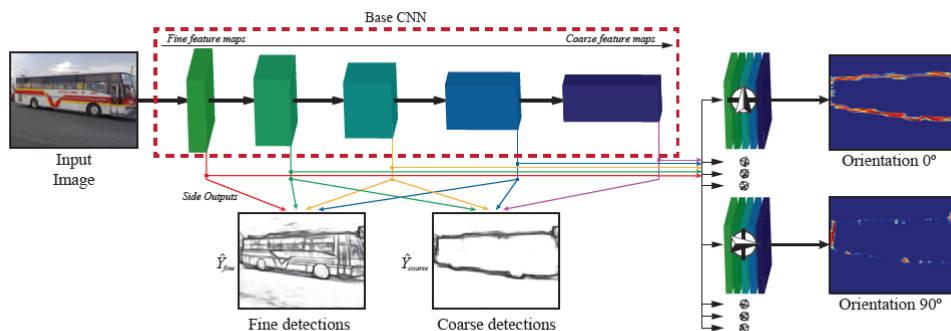


Fig. 2. Our deep learning architecture (best viewed in color). The connections show the different stages that are used to generate the multiscale contours. Orientations further require additional convolutional layers in multiple stages of the network.

Figure 2, above, illustrates a deep learning architecture depicting connections between different stages used to generate the multiscale contours using multiple feature map layers in a CNN to detect image contents at different scales (fine and coarse detections) as well as different orientations. Ex. 1007, 3. It “depicts how we make use of information provided by the intermediate layers of a CNN to detect contours and their orientations at multiple scales.” *Id.* Maninis further describes “recent approaches to contour detection using deep learning . . . [and] presenting our CNN architecture to produce contour detection.” *Id.* Maninis “start[s] from a deep network pretrained on ImageNet, such as VGG, or ResNet.” *Id.* at 4.

b) Whether Maninis Qualifies as Prior Art

Patent Owner argues that Petitioner has not demonstrated that Maninis is prior art to the '248 patent. PO Resp. 40. Specifically, Patent Owner contends that Petitioner has not shown that Maninis is a prior art printed publication. *Id.*

Petitioner contends that Maninis was published no later than May 2, 2017 on arXiv.org.⁸ Pet. 10. In support, Petitioner relies on various exhibits purporting to establish arXiv.org's policies at the time of Maninis's submission, including (1) archival snapshots of arXiv.org web pages from the Internet Archive (also known as “The Wayback Machine”); (2) the Declaration of Mr. Frank-Wright⁹; and (3) testimony from Dr. Foroosh. *Id.*

⁸ Dr. Foroosh testifies that “arXiv.org is an openly accessible, moderated repository for scholarly articles, covering an array of scientific fields.” Ex. 1002 ¶ 54.

⁹ Mr. Frank-White is a Records Request Processor at the Internet Archive, which created the Wayback Machine. Ex. 1031 ¶¶ 1, 3.

(citing Ex. 1002 ¶¶ 53–58; Ex. 1007, 1; Ex. 1022¹⁰; Ex. 1023¹¹; Ex. 1026¹²; Ex. 1024¹³; Ex. 1025¹⁴; Ex. 1021); Reply 7 (citing Ex. 1022; Ex. 1031¹⁵; Ex. 1002 ¶¶ 53–59; Ex. 1023; Ex. 1026).

We first address Patent Owner’s Motion to Exclude (Paper 34), which challenges many of Petitioner’s supporting Exhibits. *See also* PO Resp. 40–41.

(1) Patent Owner’s Motion to Exclude

Patent Owner seeks to exclude Exhibits 1022, 1023, 1025, and 1026, and paragraphs 53–58 of Dr. Foroosh’s Declaration (Exhibit 1002). PO Mot. Excl. 1– 8. Petitioner opposes the motion. Pet. Opp. Mot. Excl. 1–13. For the reasons set forth below, we deny Patent Owner’s motion.

(a) Whether Exhibit 1002 ¶¶ 53–58 Lacks Foundation and is Improper Opinion Testimony

Patent Owner argues that the Board should exclude paragraphs 53 through 58 of Exhibit 1002 because “Dr. Foroosh lacks sufficient knowledge and/or perception to rationally support the opinions he draws regarding Maninis’s publication and the practices of arXiv.org.” PO Mot. Excl. 6. In particular, Patent Owner argues that, because Dr. Foroosh has no personal

¹⁰ arXiv.org Submission Help web page from The Wayback Machine, dated May 3, 2017.

¹¹ arXiv.org Article Replacement Help web page from TheWayback Machine, dated July 18, 2017.

¹² arXiv.org Article Replacement Help web page from The Wayback Machine, dated September 8, 2016.

¹³ Maninis reference from The Wayback Machine, dated May 3, 2017.

¹⁴ arXiv.org Author Search Page for Luc Van Gool from The Wayback machine, dated July 8, 2017.

¹⁵ Third Affidavit of Mr. Frank-White, dated April 3, 2024.

knowledge regarding Maninis’s publication date, his testimony lacks foundation and is improper lay opinion testimony. *Id.* at 7. Patent Owner further argues that Dr. Foroosh’s opinions are not admissible as expert testimony because Petitioner has not shown that Dr. Foroosh “is an expert in the policies of arXiv.org or in their likely application to Maninis,” and his opinions are “pure speculation.” *Id.* at 7–8.

We agree with Petitioner that Dr. Foroosh’s testimony in paragraphs 53–58 of Exhibit 1002 has sufficient foundation. *See* Opp. Mot. Excl. 10–12. Paragraphs 53–58 of Dr. Foroosh’s declaration generally describe Dr. Foroosh’s familiarity with arXiv.org, including its process and policies for publishing submitted papers at the time that Maninis was submitted, and application of these policies to Maninis. Dr. Foroosh testifies, for example, that he was a user of arXiv.org, a registered author of numerous articles available from the system, and had submitted several papers to arXiv.org in the same field of Maninis in May 2017. Ex. 1002 ¶ 53. Therefore, Dr. Foroosh testifies, he is “familiar with the processes practiced by arXiv.org for publishing submitted papers at the time that Maninis was submitted.” *Id.* Based upon this testimony, as well as the policies of arXiv.org as reflected in Exhibits 1022, 1023, 1024, and 1026, Dr. Foroosh applies his personal familiarity and knowledge of arXiv.org to provide testimony about Maninis’s publication date. *Id.* ¶¶ 54–58.

We further agree with Petitioner that Dr. Foroosh’s testimony in paragraphs 53–58 of Exhibit 1002 is admissible. *See* Opp. Mot. Excl. 10–12. Dr. Foroosh’s testimony is admissible under Federal Rule of Evidence 701. “[I]t is possible for the same witness to provide both lay and expert

testimony in a single case.” Fed. R. Evid. 701 committee notes (2000 amendment). We find Dr. Foroosh’s testimony in paragraphs 53–58 is “(a) rationally based on the witness’s perception; (b) helpful to clearly understanding the witness’s testimony or to determining a fact in issue; and (c) not based on scientific, technical, or other specialized knowledge within the scope of Rule 702.” *See* Fed. R. Evid. 701. As such, it is admissible as opinion testimony by a lay witness. Moreover, the Board is well positioned to determine and assign appropriate weight to the evidence presented. *See, e.g., Donnelly Garment Co. v. NLRB*, 123 F.2d 215, 224 (8th Cir. 1941) (“One who is capable of ruling accurately upon the admissibility of evidence is equally capable of sifting it accurately after it has been received . . .”). Under these circumstances, we deny Patent Owner’s motion to exclude paragraphs 53–58 of Exhibit 1002.

(b) Whether Exhibits 1022, 1023, 1025, and 1026 are Inadmissible Hearsay

Each of Exhibits 1022, 1023, 1025, and 1026 is an archival web page of arXiv.org retrieved using The Wayback Machine. Patent Owner argues that Exhibits 1022, 1023, 1025, and 1026 should be excluded as inadmissible hearsay because they are out-of-court statements by arXiv.org that appear in archival webpage exhibits, and not in a qualifying declaration. PO Mot. Excl. 5. Patent Owner asserts that, because Petitioner and Dr. Foroosh offered and depended on the statements made in these exhibits “to prove the truth of the matter asserted in the statement[s]” (including the alleged policies of arXiv.org on the archival dates), they are inadmissible hearsay that should be excluded. *Id.* at 5–6 (citing Fed. R. Evid. 801 (c)).

Petitioner counters that Patent Owner's challenge is moot, because the Declaration of Mr. Frank-White (Ex. 1031) contains copies of each of the web pages shown in Exhibits 1022, 1023, 1025, and 1026, yet Patent Owner did not move to exclude Exhibit 1031. Pet. Opp. Mot. Excl. 3.

Petitioner argues that Exhibit 1025 is not inadmissible hearsay because Petitioner does not rely on Exhibit 1025 to demonstrate arXiv.org's publication policy, but rather to show that interested persons of ordinary skill in the art were provided with a link from which to directly download the Maninis reference prior to the '248 patent priority date. Pet. Opp. Mot. Excl. 3–4. According to Petitioner, “[t]his shows that Maninis was available to [persons of ordinary skill in the art] at the time” and “[t]he existence of a link is not an assertion relied on for its truth.” *Id.* at 4. Additionally, Petitioner argues that Exhibits 1022, 1023, and 1026 are admissible for non-hearsay purposes because they “collectively show the policies that were communicated to authors by arXiv.org, explaining how its publication process would work, and in particular indicating that submitted papers would be published according to a defined schedule, putting their publication within about one business day of submission.” *Id.* at 4–5. Further, Petitioner argues that, to the extent that they are hearsay, they are admissible under hearsay exceptions set forth in Fed. R. Evid. 803(3) (Then-Existing Mental, Emotional, or Physical Condition), 803(6) (Records of a Regularly Conducted Activity), and 807 (Absence of a Record of a Regularly Conducted Activity). *Id.* at 5–10.

Patent Owner responds that the link in Exhibit 1025 points to a different version of Maninis (Ex. 1021), so is not probative of Maninis's

publication date, and further argues that if Petitioner is arguing that Exhibit 1025 states which version of Maninis was linked, such statement is offered for its truth and is inadmissible hearsay. PO Reply Mot. Excl. 1. Patent Owner further argues that Petitioner fails to cite to any reliance on non-hearsay purposes for Exhibits 1022, 1023, and 1026. *Id.* Additionally, Patent Owner argues, among other things, that Petitioner cannot rely on Dr. Foroosh to establish the Rule 803(6) exception because the conditions must be “shown by the testimony of the custodian or another qualified witness.” *Id.* at 3. Patent Owner also argues that Rule 807 is reserved for “exceptional cases.” *Id.* at 4.

Patent Owner’s arguments that Exhibits 1022, 1023, 1025, and 1026 should be excluded as inadmissible hearsay are not persuasive. Petitioner provides a Declaration from Mr. Frank-White, a Records Request Processor at the Internet Archive, describing the archive process used for URLs (i.e., a website address), which includes an archive date for a given URL. Ex. 1031 ¶¶ 1–5. Attached to the Declaration “are true and accurate copies of browser screenshots of the Internet Archive’s records of the archived files for the URLs and the dates specified.” *Id.* ¶ 6. These copies of browser screenshots reflect the same URLs, dates, and content as Exhibits 1026, 1025, 1023, and 1022. Patent Owner does not present evidence that Mr. Frank-White’s testimony is unreliable or untruthful,¹⁶ that the attached screenshots are inaccurate, or that Internet Archive was unreliable.

¹⁶ Patent Owner’s argument that Petitioner never cited Exhibit 1031 in its Reply is not accurate. *See* Reply 7–8.

In addition, Petitioner submits testimony from Dr. Foroosh, describing that, among other things, he is “familiar with arXiv.org as a user of the system and registered author of numerous articles available from the system,” “submitted several papers to arXiv.org in the same field” in May 2017,” and is “familiar with the processes practiced by arXiv.org for publishing submitted papers at the time that Maninis was submitted.” Ex. 1002 ¶ 54. For example, Dr. Foroosh testifies that Exhibit 1022 explains that a submitted paper will be announced about one day after being submitted, and then mailed to all arXiv.org subscribers shortly thereafter, which is “consistent with [his] experience with arXiv.org typical practice in early 2017, as I observed regarding papers I submitted and papers I received as a subscriber during that time.” *Id.* ¶ 56. Similarly, Patent Owner does not present evidence or rebuttal that Dr. Foroosh’s testimony as to his personal knowledge of arXiv.org is unreliable or untruthful.

We determine that the Declarations of Mr. Frank-White and Dr. Foroosh provide sufficient support that Exhibits 1022, 1023, 1025, and 1026 are admissible under at least Fed. R. Evid. 803(6), the business records exception or Fed. R. Evid. 807, the residual hearsay rule.

Under Federal Rule of Evidence 803(6), records of a regularly conducted activity are not hearsay provided the opposing party has not established that the source of information or the method or circumstances of their preparation indicate a lack of trustworthiness, and the party offering the records establishes through the testimony of a qualified witness that the records are (a) made at or near the time from information transmitted by someone with knowledge, (b) kept in the course of a regularly conducted

business activity, and (c) made as a regular practice of that activity. Fed. R. Evid. 803(6). The qualified witness “who must authenticate business records need not be the person who prepared or maintained the records, or even an employee of the record-keeping entity, as long as the witness understands the system used to prepare the records.” *Conoco Inc. v. Dept. of Energy*, 99 F.3d 387, 391 (Fed. Cir. 1996). “Because of the general trustworthiness of regularly kept records and the need for such evidence in many cases, the business records exception has been construed generously in favor of admissibility.” *Id.* Similarly, under Federal Rule of Evidence 807, a hearsay statement is not excluded if (1) “the statement is supported by sufficient guarantees of trustworthiness—after considering the totality of the circumstances under which it was made and evidence, if any, corroborating the statement”; and (2) “it is more probative on the point for which it is offered than any other evidence that the proponent can obtain through reasonable efforts.”

As discussed above, Patent Owner does not provide any rebuttal evidence that the information contained in Exhibits 1022, 1023, 1025, and 1026 does not, for example, accurately reflect the submission policies (Ex. 1022), replacement policies (Ex. 1023, 1026), or search results for author “Gool_L” (Ex. 1025) or that any of the information contained therein is untrustworthy. *See, e.g., Valve Corp. v. Ironburg Inventions Ltd.*, 8 F.4th 1364, 1374–1375 (Fed. Cir. 2021) (noting that “[d]istrict courts have taken judicial notice of the contents of webpages available through the Wayback Machine ‘as facts that can be accurately and readily determined from sources whose accuracy cannot reasonably be questioned’” and stating “[w]e

agree”). Mr. Frank-Wright’s testimony establishes the date that the web pages in these exhibits were available, and Dr. Foroosh’s testimony corroborates the information contained therein, based on his personal knowledge. *See* Pet. Opp. Mot. Excl. 8–10. Under these circumstances, we deny Patent Owner’s motion to exclude Exhibits 1022, 1023, 1025, and 1026.

(2) *Analysis*

Whether a reference qualifies as a “printed publication” is a legal conclusion based on underlying factual findings, including whether the reference was publicly accessible. *Jazz Pharms., Inc. v. Amneal Pharm., LLC*, 895 F.3d 1347, 1356 (Fed. Cir. 2018)). “A reference is considered publicly accessible ‘upon a satisfactory showing that such document has been disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, can locate it.’” *Id.* at 1355–56 (citing *In re Wyer*, 655 F.2d 221, 226 (CCPA 1981)). “If accessibility is proved, there is no requirement to show that particular members of the public actually received the information.” *Constant v. Advanced Micro-Devices, Inc.*, 848 F.2d 1560, 1569 (Fed. Cir. 1988). In an *inter partes* review, the petitioner bears the burden of establishing that a particular document is a prior art printed publication. *Jazz Pharms.*, 895 F.3d at 1356 (citing *Medtronic, Inc. v. Barry*, 891 F.3d 1368, 1380 (Fed. Cir. 2018)).

Patent Owner argues that, although Petitioner has shown that Maninis was submitted to arXiv.org on April 28, 2017, Petitioner has not sufficiently identified the date Maninis was published, but has only provided two pieces

of circumstantial evidence that Maninis was published between April 28, 2017 and July 21, 2017, the priority date of the '248 patent. PO Resp. 40 (citing Ex. 1007, 1; Ex. 1002 ¶ 55; Ex. 2048, 236:17–24). First, Patent Owner contends that Petitioner produces archived copies of the arXiv.org website from 2016 and 2017 reflecting the “policy” of arXiv.org to endeavor to publish articles shortly after they are submitted. *Id.* at 40–41 (citing Ex. 1022; Ex. 1023; Ex. 1026; Ex. 1002 ¶¶ 53–56). Second, Patent Owner contends that Petitioner cites another archived copy of Maninis dated January 17, 2017, but does not rely on this copy. *Id.* at 41 (citing Ex. 1024; Ex. 1002 ¶¶ 57–58); *see also* Ex. 1021; Ex. 1002 ¶ 53. However, Patent Owner argues, because both versions of Maninis share the same URL, this suggests that only the first version was published as of the archived date. PO Resp. 41 (citing Ex. 2048, 235:5–236:8).

We are persuaded that Petitioner has sufficiently shown that Maninis is prior art to the '248 patent. There is no dispute that Maninis was submitted to arXIV.org on April 28, 2017, as is reflected in the indicia on the face of the document. Ex. 1007, 1; PO Resp. 40–41; Reply 7; Ex. 1002 ¶ 55. Therefore, the only dispute is whether Maninis was published prior to July 21, 2017.

Petitioner submits the arXIV.org Submission Help Page, dated May 3, 2017, which describes the submission process and the availability of submissions. Ex. 1022, 3. A chart is provided that describes when submissions received at certain times during the week will be announced and mailed to subscribers. *Id.* For example, submissions received between Thursday 14:00 to Friday 14:00 will be announced Sunday 20:00 and mailed

to subscribers Sunday Night / Monday Morning. *Id.* Similarly, submissions received between Friday 14:00 to Monday 14:00 will be announced Monday 20:00 and mailed to subscribers Monday Night / Tuesday Morning. *Id.* Dr. Foroosh corroborates that this is consistent with his experience with arXiv.org, that papers were published within about one business day after submission. Ex. 1002 ¶ 56. Therefore, Dr. Foroosh testifies that, since Maninis was submitted on Friday, April 28, 2017, it would have been announced on Sunday, April 30, 2017, or Monday, May 1, 2017, and would have been transmitted to subscribers no later than Tuesday, May 2, 2017. *Id.* ¶ 56.

Petitioner also provides two versions of the arXIV.org Article Replacement Help Page, dated September 8, 2016 and July 18, 2017, which both state that changes cannot be made without generating a new version of the article, and that previous versions of submitted articles are still publicly available. *See* Exs. 1023, 1026. Dr. Foroosh testifies that this is reflected in the two versions of Maninis that were submitted by Petitioner, one being the first version dated January 17, 2017, and the second version dated April 28, 2017. Ex. 1002 ¶ 57; Exs. 1021, 1007. Further, Dr. Foroosh testifies that he compared the metadata in Maninis, which indicates that second version was created and last modified on April 30, 2017, which is consistent with Maninis being placed in its final form by arXiv.org as of an announcement date of April 30, 2017, as well as his own experience. Ex. 1002 ¶ 57.

Additionally, Petitioner submits two additional exhibits providing support for Maninis's publication date. *See* Ex. 1002 ¶ 58. Petitioner submits Exhibit 1024, which is dated May 3, 2017 from the Wayback

Machine, and reflects a webpage featuring a link to arXiv.org for downloading a PDF copy of Maninis. Further, Petitioner submits Exhibit 1025, which is the arXIV.org Author Search Page for Luc Van Gool, one of the co-authors of Maninis, dated July 8, 2017. This page likewise shows a link to the Maninis article on arXiv.org. Ex. 1025, 3.

As discussed above, Petitioner submitted Mr. Frank-White's testimony that Exhibits 1026, 1025, 1023, and 1022 "are true and accurate copies of browser screenshots of the Internet Archive's records of the archived files for the URLs and the dates specified." Ex. 1031 ¶ 6. Petitioner likewise submitted testimony from Mr. Frank-Wright that Exhibit 1024 is "true and accurate copies of browser screenshots of the Internet Archive's records of the archived files for the URLs and the dates specified." Ex. 1032 ¶ 6.

We agree with Petitioner that all of the foregoing establishes that Maninis was publicly accessible prior to July 21, 2017. *See* Ex. 1002 ¶¶ 53–58; Reply 7–8; Pet. 10. Patent Owner's arguments largely address the admissibility of Petitioner's supporting exhibits, which, as discussed above, do not persuade us. *See* PO Resp. 40–41; Sur-reply 6–8. Although Patent Owner argues that "[m]any questions about Maninis's publication remain unanswered," (Sur-reply 6–7), Patent Owner does not elaborate or provide persuasive argument that Maninis was "irrevocably delayed" or that the submission and publication policies described in the arXiv.org exhibits submitted by Petitioner were not followed. Accordingly, we determine that the totality of the evidence supports that Maninis is prior art.

5. *Analysis of Independent Claim 1*

Petitioner contends that the combination of Kim, Invisalign, Salah, and Maninis teaches the limitations of independent claim 1. Pet. 27–41. Patent Owner disputes Petitioner’s contentions. PO Resp. 42–63. For the reasons set forth below, we determine that, on the complete record, Petitioner has shown by a preponderance of the evidence that independent claim 1 would have been obvious over the combination of Kim, Invisalign, Salah, and Maninis.

a) *Preamble*

The preamble recites “[a] method for assessing the shape of an orthodontic aligner, said method comprising the following steps.” Ex. 1001, 32:6–7. Petitioner contends that Kim and Invisalign teach such a method.¹⁷ Pet. 28. According to Petitioner, “Kim teaches evaluating an aligner by reviewing an image of the aligner currently worn by the patient, to determine whether the aligner is normal and appropriate.” *Id.* (citing Ex. 1005 ¶ 66). Petitioner also contends that “Invisalign teaches that evaluating a currently-worn clear aligner includes assessing the fit of the aligner, and that this assessment involves determining a distance between the teeth and the aligner when worn by the patient.” *Id.* (citing Ex. 1006, 1).

Patent Owner does not dispute Petitioner’s contentions. *See generally* PO Resp. After considering the arguments and evidence of the complete

¹⁷ Petitioner does not argue, one way or the other, whether the preamble is limiting. We make no determination whether the preamble of claim 1 is limiting.

record, we determine that Petitioner has shown by a preponderance of the evidence that Kim and Invisalign teach the recited elements of the preamble.

b) Limitation 1(a")

Limitation 1(a") recites "more than 1 week after the start of the treatment with the aligner, acquisition of at least one image at least partially representing the aligner in a service position in which it is worn by a patient, called 'analysis image', the analysis image being a photograph, or an image extracted from a film," and claim 1 further recites that "in the step a"), a cellphone is used to acquire the analysis image." Ex. 1001, 32:8–13, 32:22–23.

(1) Petitioner's Contentions

Petitioner contends that limitation 1(a") would have been obvious over Kim, Invisalign, and Salah. Pet. 29. Petitioner contends that Kim teaches that the patient's smartphone camera may be used to acquire photographs "showing a teeth alignment state of the orthodontic patient," which can further include "receiving the clear aligner information about a currently worn clear aligner," and enabling the orthodontist to "check[] a photo or a video of the clear aligner currently worn by the orthodontic patient" to "determine[] whether the clear aligner is normal and corresponds to an appropriate step." *Id.* (citing and quoting Ex. 1005 ¶¶ 55, 56, 66) (alterations in original). Petitioner further contends that Kim teaches acquiring an image at least one week after the start of treatment with the aligner, by disclosing that images may be taken recurrently based on calendared appointments. *Id.* at 32–33 (citing Ex. 1005 ¶ 83, Fig. 15).

Petitioner argues, “to the extent Patent Owner may argue Kim does not sufficiently describe the aligner currently worn and imaged is in a service position on the patient’s teeth, taking such an image would have been readily apparent in view of Invisalign’s teachings.” Pet. 21. Petitioner contends that “Invisalign provides a reason to acquire an image of the patient’s teeth with an aligner being worn in a service position: by assessing the gap visible between aligner and teeth, Invisalign teaches that it can be determined whether an aligner fits correctly (e.g., is normal and corresponds to an appropriate step), or whether it is seated or fit[s] poorly.” *Id.* at 30 (citing Ex. 1002 ¶ 88); *see also* Ex. 1006, 1; *see also* Pet. 21–22. Petitioner also contends that Invisalign teaches acquiring an image at least one week after the start of treatment with the aligner, by disclosing the evaluation of issues that may arise during treatment, and that “treatments naturally take course over many weeks, and Invisalign teaches that treatment is assessed over such periods.” Pet. 32 (citing Ex. 1006, i, 1); *see also id.* (citing Ex. 1002 ¶ 91).

Petitioner contends that, in view of Kim and Invisalign’s teachings, a person of ordinary skill in the art “would have had reason to analyze images of the teeth of a patient wearing an aligner in a service position to evaluate whether the aligner fit appropriately.” Pet. 22. According to Petitioner, the proposed “combination would be applying known methods for orthodontic evaluation of aligner fit based upon the appearance of the aligner worn on the patient’s teeth, as taught by Invisalign, in order to analyze a photo or video of the aligner worn by the patient, as taught by Kim, thereby providing feedback regarding tooth-aligner separation to aid an orthodontist regarding

whether the clear aligner is normal and corresponds to an appropriate step of treatment.” *Id.* at 22–23. Petitioner contends that Kim indicates that “employing such techniques would serve goals including enhancing accuracy, reducing the time and cost of treatment, and facilitating remote assessment.” *Id.* at 23 (citing Ex. 1005 ¶¶ 8–10, 72).

Petitioner further contends that “Salah similarly teaches acquiring dental images with a cellphone, including of teeth fitted with orthodontic appliances.” Pet. 30; *see id.* (citing Ex. 1008, 27:11–13, 31:4–7, 64:7–12, Fig. 11; Ex. 1002 ¶ 89); *see also id.* at 24. According to Petitioner, “[u]se of cellphones to acquire images depicting teeth wearing an aligner is also consistent with published methods of orthodontic practice.” Pet. 31; *see id.* (citing Ex. 1009,¹⁸ 19 (“Frey”); Ex. 1002 ¶ 90); *see also id.* at 23–24. Further, Petitioner argues that a person of ordinary skill in the art would have known how to determine the width of [gaps between the aligner and teeth] using image processing software, arguing that “Salah teaches application of computer image analysis to dental images for orthodontic treatment purposes,” where the “images may be analyzed to ‘measure the effectiveness of orthodontic treatment,’ including by ‘remotely monitor[ing] the progress of an orthodontic treatment.’” Pet. 24 (citing Ex. 1008, 46:15–24) (alteration in original).

¹⁸ Scott Frey, *DIY Dental Monitoring Solution*, ORTHO COSMOS (April 29, 2017), <http://theorthocosmos.com/blog> [<https://web.archive.org/web/20170504155213/http://theorthocosmos.com:80/blog>].

(2) Patent Owner's Arguments

Patent Owner presents three main arguments that Petitioner has not established sufficient motivation to combine Kim and Invisalign.

First, Patent Owner argues that “Petitioner’s motivation to combine Kim with Invisalign is premised on the incorrect assertion that Kim teaches the use of photographs of seated aligners.” PO Resp. 47 (citing Ex. 1002 ¶¶ 71–72). More specifically, Patent Owner asserts that Kim’s disclosure of “clear aligner information” “concerns images of the aligner itself, not a patient wearing the aligner.” *Id.* (quoting Ex. 1005 ¶ 66).

Second, Patent Owner argues that Dr. Foroosh is not qualified to provide testimony regarding Invisalign because he lacks orthodontic experience, and, is therefore “unable to understand key portions of Invisalign or explain the meaning of terms appearing on the same pages of Invisalign that he cites.” PO Resp. 49–51 (citing, e.g., Ex. 2054, 33:14–34:11, 36:5–17, 38:18–39:24; Ex. 1002 ¶¶ 47–48).

Third, Patent Owner argues that a person of ordinary skill in the art would not have been motivated to assess aligner fit by using an aligner image. PO Resp. 51. Patent Owner presents several arguments relating to the combination of Kim and Invisalign. Patent Owner argues that “Kim does not disclose the use (or usefulness) of photographs showing seated aligners,” but, rather “expressly relates to ‘remote teeth alignment services.’” *Id.* (citing Ex. 2028 ¶¶ 69, 70, 185, 186; Ex. 1005 ¶ 10; Ex. 2030 ¶ 76). Patent Owner draws a distinction between assessing teeth alignment and assessing aligner fit, arguing that Kim does not purport to provide a new way to assess aligner fit from a photograph, and Invisalign is concerned with

in person-analysis, where orthodontists perform certain steps at each appointment that cannot be performed remotely. *Id.* at 52 (citing Ex. 2030 ¶ 58). Moreover, Patent Owner argues that the images in Invisalign were not acquired on a cellphone, and a person of ordinary skill in the art “would have recognized that the images in Invisalign were taken by trained professionals with a more sophisticated camera than a 2017 cellphone.” *Id.* (citing Ex. 2054, 71:11–14, 134:10–135:11; Ex. 2030 ¶ 67). Patent Owner argues that Invisalign does not suggest using cellphones to assess aligner fit, nor suggest measuring the separation on an image to assess aligner fit. *Id.* at 52–53 (citing Ex. 2028 ¶ 187). In short, Patent Owner argues “nothing in Kim or Invisalign suggests that the in-person techniques of Invisalign could be successfully replaced with computer-implemented analyses on patient-initiated photographs captured using a cellphone.” *Id.* at 53 (citing Ex. 2028 ¶ 189).

Patent Owner also argues against the combination of Kim, Invisalign, and Salah.¹⁹ Patent Owner argues that, “[a]lthough Salah includes one image showing a device positioned on the teeth, that device” is “not a removable aligner.” PO Resp. 54 (citing Ex. 1008, Fig. 11; Ex. 2028 ¶ 190; Ex. 2030 ¶¶ 83–84). Moreover, Patent Owner asserts, “Salah does not describe any method for assessing the fit of a device.” *Id.* Patent Owner also argues that Petitioner’s motivation to combine Kim with Salah is “based on the faulty premise that Kim ‘teaches application of computer image

¹⁹ We address additional arguments regarding the combination with Salah in Section III.D.5.c.3 below.

analysis to dental images,”” but “Kim discloses no computer image analysis.” *Id.* at 48 (emphasis omitted).

We address each of Patent Owner’s arguments below.

(3) *Analysis*

Petitioner has shown, by a preponderance of the evidence, that the combination of Kim, Invisalign, and Salah teaches limitation 1(a”), and has persuasively explained why a person of ordinary skill in the art would have been motivated to combine Kim, Invisalign, and Salah.

Generally, Patent Owner’s arguments against the combination of Kim, Invisalign, and Salah (1) address the references separately, rather than in combination as proposed by Petitioner; (2) argue that the references themselves do not teach the motivation to combine; or (3) argue features in the references that are not relied upon by Petitioner for this particular limitation. These arguments are not persuasive. *See, e.g., In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986) (“Non-obviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of references.”); *DyStar Testilfarben GmbH v. C.H. Patrick Co.*, 464 F.3d 1356, 1368 (Fed. Cir. 2006) (stating that motivation to combine prior art references may exist “even absent any hint of suggestion in the references themselves”).

We begin by reiterating how Petitioner relies on each of the references to teach limitation 1(a”): “more than 1 week after the start of the treatment with the aligner” (Kim and Invisalign), “acquisition of at least one image at least partially representing the aligner in a service position in which it is worn by a patient, called ‘analysis image’, the analysis image being a

photograph, or an image extracted from a film,” (Kim or Kim, Invisalign, and Salah), and “in the step a”), a cellphone is used to acquire the analysis image” (Kim and Salah). Pet. 29–34.

(a) Whether Kim or Kim, Invisalign, and Salah Teaches “acquisition of at least one image at least partially representing the aligner in a service position in which it is worn by a patient, called ‘analysis image’”

There is no dispute that Kim teaches using a smartphone or mobile device to acquire an image of a patient’s teeth. *See, e.g.*, Ex. 1005 ¶¶ 1, 10, 13 (describing “photographing step information, . . . and a front-view teeth photo, a bottom-view low-angle teeth photo, . . . which are taken using a camera of the orthodontic patient terminal”), 42 (describing that the orthodontic patient terminal is not limited to a smartphone and may also be a mobile device), 56, 58 (describing “a teeth contour automatic recognition photographing program 647 for displaying a virtual teeth line on the screen of the orthodontic patient terminal 10 and automatically recognizing and taking a photo of the teeth of the orthodontic patient shown on the screen”). However, in various instances, Kim refers to the “currently worn clear aligner” or a “clear aligner to be currently worn” (e.g., Ex. 1005 ¶¶ 10, 66), and the parties dispute whether this refers to the patient wearing the aligner when the photograph is taken (as Petitioner argues) or whether it simply refers to the aligner by itself that the patient is currently using (as Patent Owner argues). Pet. 29; PO Resp. 47; Sur-reply 14–15.

Kim at least *suggests* that a photograph may be acquired while the aligner is being worn. For example, Kim describes that:

The clear aligner information transmission program **69** may be a program for receiving the *clear aligner information about a*

currently worn clear aligner from the orthodontic patient terminal 10, storing the clear aligner information, and transmitting the clear aligner information to the orthodontist terminal 20 in such a manner that the orthodontist checks a photo or a video of the clear aligner currently worn by the orthodontic patient, and determines whether the clear aligner is normal and corresponds to an appropriate step.

Ex. 1005 ¶ 66 (emphasis added); *see also id.* ¶¶ 13 (teeth alignment report information may include photographs taken using a camera of the orthodontic patient terminal), 14 (teeth alignment report information input program may include various guidance information for taking the photograph), 20 (based on the teeth alignment report information, determining that an additional or modified clear aligner is needed, and transmitting a clear aligner information to a clear aligner manufacturing terminal), 64 (teeth alignment guidance information may include at least one of a clear aligner information about a clear aligner to be worn in a current step among a clear aligner set); *see also id.* ¶¶ 56, 58.

Patent Owner argues that the disclosure in paragraph 66 cited above refers to a photograph of the clear aligner by itself (PO Resp. 47; Ex. 2030 ¶ 74); however, Patent Owner does not identify any disclosure in Kim that describes taking a photograph of the clear aligner by itself. Rather, the photograph provided in the teeth alignment report information in Kim describes photographs taken of the patient's mouth and jaw area. Ex. 1005, ¶¶ 13, 56, 87. Further, Patent Owner's argument that Kim's image is not used for diagnostic or treatment purposes (PO Resp. 47), is not supported by the disclosure in Kim. Paragraph 66 of Kim, reproduced above, explicitly states that "the orthodontist checks a photo or a video of the clear aligner

currently worn by the orthodontic patient, and determines whether the clear aligner is normal and corresponds to an appropriate step.”

Even if Kim only teaches taking a photograph of the patient’s teeth with no aligner in place, we agree with Petitioner that taking the photograph with the seated aligner in place would have been obvious in view of the teachings in Invisalign and Salah. Pet. 21, 29–31; Reply 14. That is, Salah teaches using a cellphone to acquire an image of the patient’s teeth while the user is wearing an orthodontic appliance and analyzing that image. Ex. 1008, 27:11–13, 31:4–7, 34:5–36:15, 64:7–12, Fig. 11. And, as Petitioner argues, “Invisalign provides a reason to acquire an image of the patient’s teeth with an aligner being worn in a service position: by assessing the gap visible between aligner and teeth, Invisalign teaches that it can be determined whether an aligner fits correctly (e.g., is normal and corresponds to an appropriate step), or whether it is seated or fit poorly.” Pet. 30 (citing Ex. 1002 ¶ 88); *see also id.* at 21–23.²⁰ Patent Owner’s arguments that the images in Invisalign were not taken on a cellphone are beside the point (and Invisalign is not relied upon for that teaching), given the disclosures in both Kim and Salah that teach acquiring dental images using a cellphone. *See* PO Resp. 52–53.

*(b) Whether Dr. Foroosh Failed to Properly Analyze
Invisalign*

We are not persuaded by Patent Owner’s arguments that Dr. Foroosh does not understand “key portions” of Invisalign nor does he “explain the

²⁰ Patent Owner argues that Dr. Foroosh is not qualified to offer this opinion. PO Resp. 52. However, for the reasons described in Section III.B. and in Section III.D.5.b.3.b below, we disagree.

meaning of terms appearing on the same pages of Invisalign that he cites.” PO Resp. 49; *see* Reply 15–16.

Patent Owner provides no explanation as to why the terms Patent Owner’s counsel chose to ask Dr. Foroosh about during deposition (e.g., “auxiliary,” “interproximal reduction,” “patient compliance,” “unengaged attachment,” “scalar”) are relevant to the challenged claims of the ’248 patent, or the combination as proposed by Petitioner. *See* Reply 16. As described in the Petition, “Invisalign provides a reason to acquire an image of the patient’s teeth with an aligner being worn in a service position.” Pet. 30 (citing Ex. 1002 ¶ 88). Patent Owner’s argument that Dr. Foroosh did not understand the Invisalign reference because he could not provide a dentist’s or orthodontist’s opinion on what certain medical terms mean is not persuasive. However, we note that in several instances Dr. Foroosh indicated familiarity with the terms. For example, when asked about the term “interproximal reduction,” Dr. Foroosh testified that “I have come across this term back when I was working on imaging sciences on that project; so I am familiar with treatments for, you know, creating spaces between teeth.” Ex. 2054, 36:5–10. Dr. Foroosh also testified “I know what scalars are. They’re in dentists’ offices.” *Id.* at 65:12–18.

Patent Owner also argues that Dr. Foroosh disregarded certain portions of Invisalign that describe methods for assessing aligner fit that can only be performed in person (PO Resp. 49–50; Sur-reply 16–17), but there is no dispute that Invisalign methods were performed in person. *See, e.g.*, Ex. 2054, 66:14–15 (Dr. Foroosh stating that “I consider Invisalign not a remote treatment disclosure”), 67:5–7 (Dr. Foroosh stating that “I understand that

Invisalign is not disclosing a remote assessment or treatment”); Ex. 2030 ¶ 58. We further note that, as Petitioner points out (Reply 3), Dr. Kusnoto testified that, “with the exception of the illustration of poor fit,” Dr. Foroosh is “getting the terminology correct.” Ex. 1052, 44:1–45:11.

(c) Whether Petitioner has Established Motivation to Combine Kim, Invisalign, and Salah

Patent Owner argues that a person of ordinary skill in the art would not have been motivated to assess aligner fit using an aligner image. PO Resp. 51. Patent Owner incorrectly focuses on whether any one of the references teaches assessing aligner fit using an image, rather than Petitioner’s proposed combination and reasons explaining why a person of ordinary skill in the art would have been motivated to do so.

With respect to Kim, although we recognize that there is a difference between teeth alignment and aligner fit (*see* PO Resp. 48, 51), the record supports a relationship between the two. For example, Kim describes “providing remote teeth alignment services to remotely advise an appropriate step of a clear aligner using a smartphone of an orthodontic patient.” Ex. 1005 ¶ 1; *see also id.* ¶ 66 (stating that the orthodontist “determines whether the clear aligner is normal and corresponds to an appropriate step”). Further, in discussing conventional clear-aligner treatment, Kim states “an orthodontic patient should regularly visit a dental clinic for a long period of time to allow a dentist to accurately check the state of his/her teeth and determine a currently appropriate step of a clear aligner.” Ex. 1005 ¶ 8; *see also* Ex. 2030 ¶¶ 46–49 (Dr. Kusnoto testifying that in a conventional in-person analysis, the orthodontist would first visually inspect the current state of dentition and compare that state to the

anticipated dentition expected at that point in the treatment, and second assess the aligner treatment); Ex. 1001, 27:55–59 (“At regular intervals, the patient goes to the orthodontist for a visual inspection, notable to check whether the displacement of the teeth confirms to the expectations and whether the aligner worn by the patient is still suited to the treatment.”). The record also supports Petitioner’s contentions that assessment of an aligner is naturally made when the aligner is worn on the teeth. *See* Reply 13–14. For example, Dr. Kusnoto testifies that, “[g]enerally, a patient was asked to try on their current aligner, and each aligner was visually and manually examined for large gaps between the aligner and the teeth.” Ex. 2030 ¶ 49.

Patent Owner fails to persuasively address Petitioner’s motivation to combine the references. *See* Pet. 20–23. Rather, Patent Owner’s arguments attack the references individually and fail to persuasively address Petitioner’s extensive reasoning. For example, Patent Owner argues that Kim does not suggest providing a new way to assess aligner fit from a photograph, Invisalign does not indicate that images taken with a cellphone would be suitable for assessing aligner fit, Invisalign does not suggest measuring separation on an image to assess aligner fit, and neither reference suggests that Invisalign’s in-person techniques could be successfully replaced with computer-implemented analyses on patient-initiated photographs captured using a cellphone. PO Resp. 51, 53. However, the motivation need not come from the references themselves, *see DyStar*, 464 F.3d at 1356, and these arguments do not directly address Petitioner’s stated motivation to combine the references. *See* Pet. 20–27. For example, *Dystar*

states that motivation can arise when the combination “create[s] a faster, cheaper, and more convenient . . . process.” PO Resp. 56–57 (citing *Dystar*, 464 F.3d 1356 at 1358). Petitioner provides similar types of reasons for the combination here, citing Kim, that “employing such techniques would serve goals including enhancing accuracy, reducing the time and cost of treatment, and facilitating remote assessment.” Pet. 23 (citing Ex. 1005 ¶¶ 8–10, 72). We find that Petitioner’s reasoning provides persuasive support that a person of ordinary skill in the art “would have been motivated” to combine the references, and Patent Owner has not persuasively argued otherwise. *See InTouch Techs., Inc. v. VGO Commc’ns, Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014).

Moreover, Patent Owner’s focus on Kim and Invisalign does not take into account Petitioner’s reliance on Salah, which teaches “application of computer image analysis to dental images for orthodontic treatment purposes.” Pet. 24 (citing Ex. 1008, code (57), 8:19–28, 13:24–28, 31:4–9). We do not find persuasive Patent Owner’s arguments against the combination of Salah with Kim, for the reasons set forth by Petitioner. Reply 14–15. That is, we agree with Petitioner that Salah teaches application of computer image analysis to dental images for orthodontic treatment purposes, and that Kim also teaches analysis of images on computers. *Id.*; *see also* Pet. 24. As described above, Kim teaches taking a photograph of (at minimum) the patient’s teeth on a smartphone, including guidance information on how to take that photograph, and transmitting that photograph to an orthodontist terminal for the orthodontist to check. E.g., Ex. 1005 ¶¶ 55–58, 66. Likewise, Patent Owner’s arguments that “Salah

does not describe any method for assessing the fit of a device” are not persuasive because Petitioner does not rely on Salah to teach a method for assessing the fit of a device. *See* Pet. 24–26, 30, 34–35.

Moreover, we disagree with Patent Owner’s arguments that the purported benefits of Kim that Petitioner relies upon – enhancing accuracy, reducing the time and cost of treatment, and facilitating remote assessment – only stem from its use of teeth alignment information. PO Resp. 47. Rather, these benefits are a direct result of Kim’s ability to provide *remote* teeth alignment services, where the condition of the patient may be *remotely* and accurately diagnosed, and the information about the accurate step of a clear aligner to be currently worn may be *remotely* provided. Ex. 1005 ¶ 10; *see also id.* ¶¶ 8–9; *see* Reply 16. In fact, the problems described in Kim leading to remote teeth alignment services are nearly identical to the problems described in the ’248 patent. Ex. 1005 ¶ 9 (describing that if a patient is not able to frequently visit the dental clinic, or stops visiting the dental clinic, problems can occur such as increased time and cost); Ex. 1001, 1:54–58 (describing that the need to travel to the orthodontist’s is a burden on the patient and can lead to additional expense). These disclosures support Petitioner’s reasons to combine the references.

In short, we are persuaded by Petitioner’s reasoning,²¹ which is supported by testimony from Dr. Foroosh, that the combination “appl[ies]

²¹ Petitioner also relies on Frey to support the argument that “[u]se of cellphones to acquire images depicting teeth wearing an aligner is also consistent with published methods of orthodontic practice.” Pet. 31 (citing Ex. 1009, 19). Our determination does not depend on Petitioner’s reliance

known methods for orthodontic evaluation of aligner fit based upon the appearance of the aligner worn on the patient's teeth, as taught by Invisalign, in order to analyze a photo or video of the aligner worn by the patient, as taught by Kim[, Invisalign, and Salah],^[22] thereby providing feedback regarding tooth-aligner separation to aid an orthodontist regarding whether the clear aligner is normal and corresponds to an appropriate step of treatment." *See* Pet. 22–23. Petitioner provides extensive persuasive reasons for the combination, such as those as stated in Kim, of "enhancing accuracy, reducing the time and cost of treatment, and facilitating remote assessment," and Invisalign's teachings of "how to evaluate aligner fit." *Id.* at 20–23 (citing Ex. 1005 ¶¶ 8–10, 72).

(d) Conclusion Limitation 1(a")

After considering the arguments and evidence of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that the combination of Kim, Invisalign, and Salah teaches this limitation, and has persuasively explained why a person of ordinary skill in the art would have been motivated to combine Kim, Invisalign, and Salah.

on Frey. That is, Frey is not necessary to support our determination that Petitioner has shown by a preponderance of the evidence that a person of ordinary skill in the art would have been motivated to combine Kim, Invisalign, and Salah. Therefore, we do not address Patent Owner's arguments regarding Frey. *See* PO Resp. 56–57.

²² As described above, Petitioner alternatively relies on Kim, Invisalign, and Salah to teach the photo of the aligner worn by the patient. *See* Pet. 21, 29–31.

c) Limitation 1(b")

Limitation 1(b") recites "analysis of the analysis image by means of a deep learning device, trained by means of a learning base, so as to determine a value for at least one tooth attribute of an 'analysis tooth zone' representing, at least partially, a tooth on said analysis image, the tooth attribute relating to a separation between the tooth represented by the analysis tooth zone, and the aligner represented on the analysis image." Ex. 1001, 32:14–21.

(1) Petitioner's Contentions

Petitioner contends that limitation 1(b") would have been obvious over the combination of Kim, Invisalign, Salah, and Maninis. Pet. 34 (citing Ex. 1002 ¶¶ 93–94).

Petitioner contends that "Salah teaches that dental images may be analyzed to detect 'discriminant information,' which can include contours of objects depicted in the images, including teeth and other intraoral objects such as gums." Pet. 34 (citing and quoting Ex. 1008, 34:5–14, 55:21–56:7). According to Petitioner, the "contours may be detected using deep learning." *Id.* at 35 (citing Ex. 1008, 36:14; Ex. 1002 ¶ 96).

Petitioner contends that Maninis teaches applicable deep learning techniques for contour and object detection, and that "Maninis's use of a computing device comprising a trained deep-learning convolutional neural network to analyze images matches the '248 patent's preferred embodiment." Pet. 36–38 (citing, e.g., Ex. 1001, 1:24–25, 16:9–36; Ex. 1007, 2, 3–5, 9, Fig. 2); *see also id.* at 24–25.

According to Petitioner, a person of ordinary skill in the art “would have been motivated to use [Maninis’s] techniques to identify teeth and aligners depicted in orthodontic images by detecting their contours and identifying the objects found within each contour.” Pet. 38. Petitioner argues:

Based on Maninis’s flexibility and prospect to improve performance, a [person of ordinary skill in the art] would have been motivated to analyze images using a deep learning device as taught by Maninis to improve image acquisition and analysis apparatus as taught by Salah and Kim. For example, a [person of ordinary skill in the art] would have been motivated to adapt Salah and Kim’s image acquisition and analysis apparatus to employ a deep learning architecture as taught by Maninis, trained on images relevant to the dental imaging applications of Salah, Kim, and Invisalign. Maninis’s deep learning architecture would provide specific functionalities required by Salah, Kim, and Invisalign, including the ability to identify objects (such as the teeth and aligners depicted in each image) and to detect contours (such as the edges of teeth and aligners useful to assess aligner fit as taught by Invisalign).

Id. at 26 (citing Ex. 1002 ¶ 78).

Petitioner contends that the adjustments to Maninis’s deep learning device, which “include providing an appropriately annotated training set and setting output layers to provide the required object identifications corresponding to the labels used to identify the locations of teeth, aligners, and the gaps between them,” would have been “straightforward and well within the skill level of the [person of ordinary skill in the art].” Pet. 38. (citing Ex. 1002 ¶ 102); *see also* Ex. 1002 ¶¶ 102–103 (cited at Pet. 38–39).

Petitioner contends that a person of ordinary skill in the art would have been motivated in view of Kim and Invisalign to apply the contour-detection techniques of Salah and Maninis to detect edges of teeth and aligners depicted in images of patient's teeth so that the assessment of gap between aligner and teeth could be made, as taught by Invisalign. For example, because the detected edges of the aligner and teeth correspond to the edges of the physical objects depicted, a [person of ordinary skill in the art] would have understood that measuring the distance between the outlines of the teeth and the aligner as detected by Salah's image processing software would allow determination of the gap between each tooth and the corresponding part of the aligner.

Pet. 39–40 (citing Ex. 1002 ¶ 104); *see also id.* at 26–27. Petitioner contends that, contour detection of a region (as taught by Maninis) containing a tooth (alone, or a tooth and an aligner surface separated by a gap) constitutes an analysis tooth zone at least partially representing a tooth on the analysis image. *Id.* at 40–41 (citing Ex. 1007, Abstract, 3–5; Ex. 1002 ¶ 106). In addition, Petitioner argues, “this analysis would generate tooth attributes, including the locations of the surfaces of the tooth and aligner (corresponding to detected contours), as well as the measured separation between them (the distance between the contours), consistent with the teachings of Invisalign.” *Id.* at 41 (citing Ex. 1002 ¶ 107).

Petitioner contends that “[t]he resulting combination would use each reference's teachings to perform substantially the same function as they provide alone, applying the contour detection taught by Salah and Maninis to detect edges of teeth and aligners to produce a measurement of distance between these surfaces, as taught by Invisalign, to assess whether the imaged aligner fits appropriately for the current step in patient treatment, as taught

by Kim.” Pet. 27. Petitioner contends that a person of ordinary skill in the art would “have had a reasonable expectation of success, as the combination would be one of complementary techniques, applied in understood ways, to produce a predictable outcome.” *Id.* (citing Ex. 1002 ¶¶ 80–81).

(2) Patent Owner’s Arguments

Patent Owner argues that a person of skill in the art would not have been motivated to combine Kim, Salah, and Invisalign with Maninis to teach limitation 1(b”). PO Resp. 58.

First, Patent Owner argues that the proposed combination is inoperable because “the Maninis COB network is incapable of being trained [in the manner proposed by Petitioner] or performing such an analysis.” PO Resp. 42–43 (citing Ex. 2028 ¶¶ 172–183).

Second, Patent Owner argues that Dr. Foroosh relies on impermissible hindsight, rather than the motivations and teachings of the art in 2017. PO Resp. 59 (citing Ex. 2054, 157:21–158:23, 159:10–13, 178:20–179:2; Ex. 2059 ¶ 83).

Third, Patent Owner presents various arguments challenging Petitioner’s motivation to combine the references, and argues that a person of ordinary skill in the art would not have been motivated to assess aligner fit using a deep learning device. PO Resp. 60–62.

Fourth, Patent Owner argues that the significant time and expense associated with implementing Maninis’s deep learning architecture to assess aligner images weighs against any motivation to combine the references. PO Resp. 62–63.

We address each of Patent Owner’s arguments below.

(3) *Analysis*

Petitioner has shown, by a preponderance of the evidence, that the combination of Kim, Invisalign, and Salah teaches limitation 1(b”), and has persuasively explained why a person of ordinary skill in the art would have had reasons to combine Kim, Invisalign, Salah, and Maninis, with some rational underpinning, and would have had a reasonable expectation of success in doing so.

We again begin by setting forth how Petitioner relies on each of the references to teach limitation 1(b”): “analysis of the analysis image” (Salah and Maninis) “by means of a deep learning device” (Salah and Maninis), “trained by means of a learning base” (Maninis), and “so as to determine a value for at least one tooth attribute of an ‘analysis tooth zone’ representing, at least partially, a tooth on said analysis image, the tooth attribute relating to a separation between the tooth represented by the analysis tooth zone, and the aligner represented on the analysis image” (Salah and Maninis). We address each of Patent Owner’s arguments in turn.

(a) *Whether the Combination is Inoperable*

Patent Owner’s argument that the combination is inoperable is based on a mischaracterization of Petitioner’s arguments. *See* Reply 9. Patent Owner argues that “[t]he Maninis COB neural network can be trained *only* on contours and can identify in an image *only* contours,” but “is incapable of determining *what those objects might be.*” PO Resp. 44 (citing Ex. 2028 ¶¶ 178–179). Patent Owner argues “[a]s Maninis itself discloses, another neural network is required to make that kind of ‘semantic’ determination.” *Id.* Patent Owner argues that, “[a]lthough Maninis refers to other neural

networks, which are described by different authors in different papers not in evidence in this proceeding, Petitioner cannot rely on that disclosure now.” *Id.* at 44–45 (emphasis omitted).

However, Petitioner explicitly relies on the “semantic” determination disclosed in Maninis. *See, e.g.*, Pet. 37–39 (citing, e.g., Ex. 1007, 11–12, Tables 4–12). As argued by Petitioner, “[t]he petition repeatedly cites to that section of Maninis (section 6, pages 11–13) when explaining that Maninis uses neural networks not only to detect contours, but also uses the regions identified by those contours to classify objects.” Reply 9–10 (citing Pet. 10, 25, 37–38, 45, 53; Ex. 1002 ¶¶ 59, 75, 77, 101, 102). Therefore, to the extent Patent Owner argues that Petitioner exclusively relies on Maninis’s COB neural network to teach the claimed “a deep learning device trained by means of a learning base,” we disagree. At no point does Petitioner exclusively rely on Maninis’s COB neural network to teach step 1(b”) and any arguments from Patent Owner premised on this assertion are not responsive to Petitioner’s contentions.

Further, we do not agree with Patent Owner’s argument that, because Maninis’s deep learning architecture is only trained to identify contours, which are used to classify objects, it is incapable of being trained to perform the claimed image analysis. PO Resp. 42–46, 68–70. Claim 1 does not identify a particular type of deep learning device; it suffices that the deep learning architecture disclosed by Maninis is capable of performing the claimed image analysis. The ’248 patent describes that “a deep learning device, preferably a neural network, is trained with the learning base.” Ex. 1001, 16:5–6. The ’248 patent further provides a non-limiting list of neural

networks, including “networks specializing in the classification of images, called ‘CNN’ (‘convolutional neural network’).” *Id.* at 16:9–11. This is the same deep learning architecture taught by Maninis and relied on by Petitioner. *See* Pet. 36–37 (arguing that “Maninis’s use of a computing device comprising a trained deep-learning [CNN] to analyze images matches the ’248 patent’s preferred embodiment”); *see also* Ex. 1007, Abstract, 3–5, Fig. 2.

(b) Whether the Proposed Combination is a Product of Impermissible Hindsight

We do not find Patent Owner’s impermissible hindsight arguments to be persuasive. In support of these arguments, Patent Owner compares Dr. Foroosh’s approach in this proceeding to his approach in related IPR2024-00110, where the claims at issue do not require deep learning, and Dr. Foroosh relies on a different, non-deep learning method identified as “preferred” in Salah. PO Resp. 59. However, Patent Owner does not dispute that Salah discloses various processes to detect high-contrast regions and determine contours, including “the following well-known and preferred methods” such as “applying a Canny filter,” as well as “not preferred” methods such as deep learning. Ex. 1008, 34–36. In connection with these processes, Salah also states that “[a] person of skill in the art [would] know how to process an updated image to reveal discriminant information . . . for example, [by using] the application of well-known masks or filters provided by image processing software . . . to detect high-contrast regions and determine contours.” *Id.* at 34:11–14. As argued by Petitioner, and we agree, “Salah clearly teaches deep learning and other image processing algorithms are options to determine contours and other discriminant

information,” and “similar motivations would lead [persons of ordinary skill in the art], at their preference, to either use deep learning . . . or use the other image processing techniques taught by Salah.” Reply 19–20. Therefore, contrary to Patent Owner’s arguments, Dr. Foroosh’s testimony is based upon the express disclosure of Salah, not hindsight. *See, e.g., In re Gartside*, 203 F.3d 1305, 1319 (Fed. Cir. 2000) (stating that “the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references,” which “may come from . . . the teachings of the references themselves”) (quoting *In re Dembiczak*, 175 F.3d 994, 998 (Fed. Cir. 1999)).

(c) Rationale to Combine with a Reasonable Expectation of Success

Based on the complete record, we are persuaded that Petitioner has presented a sufficient rationale to combine the teachings of Kim, Invisalign, Salah, and Maninis with a reasonable expectation of success. *See* Pet. 20–27.

Patent Owner’s arguments that a person of ordinary skill in the art would not have been motivated to assess aligner fit using a deep learning device are not persuasive. We agree with Petitioner that “Salah teaches that dental images may be analyzed [using deep learning] to detect ‘discriminant information,’ which can include contours of objects depicted in images, including teeth or other intraoral objects, such as gums.” Pet. 34–35 (citing e.g., Ex. 1008, 34:11–36:14, 55:21). To that end, we disagree with Patent Owner that a person of ordinary skill in the art “would not have viewed

Salah as a general teaching to apply ‘computer image analysis to entail images for orthodontic treatment purposes.’” PO Resp. 60.

Patent Owner’s argument that Salah would not have provided motivation because it states that “deep learning” is “not preferred” (PO Resp. 60) is not persuasive. *See In re Fulton*, 391 F.3d 1195, 1200 (Fed. Cir. 2004) (“[O]ur case law does not require that [the] particular combination must be the preferred, or the most desirable, combination described in the prior art in order to provide motivation for the current invention.”); *In re Mouttet*, 686 F.3d 1322, 1334 (Fed. Cir. 2012) (stating “just because better alternatives exist in the prior art does not mean that an inferior combination is inapt for obviousness purposes”). Further, as Petitioner points out (Reply 21), Salah teaches that its image analysis is “best carried out either on the patient’s own device, preferably using the device used in step b), **or** with an app at a dental professional’s office, **or** with a dedicated third-party server,” (Ex. 1008, 33:6–8, emphasis added), so Patent Owner’s arguments that because “Salah’s image analysis is ‘best carried out . . . on the patient’s own device’” it would have discouraged a person of ordinary skill in the art from using deep learning (PO Resp. 60) is likewise not persuasive for the same reasons.

We are also not persuaded by Patent Owner’s argument that Salah teaches away from the combination because it teaches that “low-contrast” areas will produce low quality contours. PO Resp. 55–56 (citing Ex. 1008, 60:17–61:3; Ex. 2028 ¶¶ 124, 171 191; Ex. 2030 ¶ 84); Sur-reply 18–19. “A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out

in the reference, or would be led in a direction divergent from the path that was taken by the applicant.” *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1327 (Fed. Cir. 2009) (quoting *Ricoh Co., Ltd. v. Quanta Comput. Inc.*, 550 F.3d 1325, 1332 (Fed. Cir. 2008)). A reference does not teach away “if it merely expresses a general preference for an alternative invention but does not ‘criticize, discredit, or otherwise discourage’ investigation into the invention claimed.” *Id.* (quoting *In re Fulton*, 391 F.3d at 1201).

Relying on testimony from Dr. Kusnoto and Dr. Mongan, Patent Owner argues that, “[b]ecause aligners visually blend with teeth, they represent areas of low contrast.” PO Resp. 55 (citing Ex. 2030 ¶ 84; Ex. 2028 ¶ 124). We find persuasive Dr. Foroosh’s testimony that “Salah does not teach that only maximal-contrast areas can produce useful contours.” Ex. 1048 ¶ 23. There is no persuasive evidence in the record that aligners on teeth represent areas of unacceptably low contrast. *See* Reply 17 (citing Ex. 1051, 60:6–62:13; Ex. 1048 ¶ 23). For example, Dr. Mongan testified that he “didn’t see a need to run any tests to confirm something that I think was clear to me and was confirmed by . . . [Dr. Kusnoto]” and that an “image with an aligner in a service position would likely have a lower contrast than equivalent image without the aligner there.” Ex. 1051, 60:6–14, 62:3–13.

Rather, Dr. Foroosh provided examples of edge detection in an image from Invisalign, as well as images that Dr. Kusnoto asserted would have been representative of aligner fit, using Canny edge detection and bilateral

filtering techniques,²³ which show sufficient contrast to detect edges. Ex. 1002 ¶ 103; Ex. 1048 ¶¶ 20–21. We find persuasive these examples provided by Dr. Foroosh, as to how the combined system would work, and in particular, that “the photographs of Kim, Salah, and Invisalign are ordinary camera images such as those acquired by a cellphone, [so] they show essentially the same thing a person would see when viewing teeth and an aligner in real life. The ability to see a gap and virtually assess it in real life naturally maps over the ability to detect and measure the same gap using computer vision techniques like Salah and Maninis’s contour and edge detection.” Ex. 1002 ¶ 103; *see* Ex. 1048 ¶¶ 20–21.

Dr. Foroosh further testifies that “the edges of teeth and aligners, and the gap between them, can be resolved even with simple edge detection techniques,” so “[a]pplying more advanced techniques, such as the deep learning taught by Salah and Maninis, would have been expected to resolve the locations of each tooth’s edge and the corresponding aligner edges with even greater precision and accuracy.” Ex. 1048 ¶ 21. Further, Dr. Foroosh provides testimony that Maninis “teaches how contours of different strengths may be used advantageously to discern shapes of objects (and parts of objects) at varying levels of detail.” Ex. 1048 ¶ 24; *see also* Ex. 1002 ¶¶ 59, 97, 131. Accordingly, we are not persuaded that Salah teaches away from the combination.

We further agree with Petitioner that “[a]pplicable deep learning techniques for contour and object detection are taught by Maninis,”

²³ Salah discloses using Canny edge detection and bilateral filtering techniques. Ex. 1008, 34:11–35:11.

including “methods of detecting edges (or ‘contours’) in images with a computing device using a deep learning neural network to perform image analysis,” and “us[ing] the contours it generates to define boundaries around regions and to identify the objects in each region of the image.” Pet. 36–38 (citing, e.g., Ex. 1007, Abstract, 1–5, 11–12, Figs. 2–5). As discussed above in Section III.D.5.c.3.a, Patent Owner’s argument that Maninis’s COB neural network does not conduct semantic segmentation is not persuasive because it is not responsive to Petitioner’s contentions. *Id.* at 10, 25, 37–38, 45, 53; Ex. 1007, 11–12.

In summary, Salah is generally relied upon to teach analyzing a dental image using deep learning to detect contours, including teeth or gums. Pet. 34–35. Maninis provides further detail describing the use of deep learning techniques for contour and object detection in an image, including to define the boundaries around regions and to identify the objects in each region of the image. *Id.* at 36–38. For the reasons set forth by Petitioner (*id.* at 24–27, 34–41), we are persuaded that a person of ordinary skill in the art “would have been motivated in view of Kim and Invisalign to apply the contour-detection techniques of Salah and Maninis to detect edges of teeth and aligners depicted in images of patient’s teeth so that the assessment of gap between aligner and teeth could be made, as taught by Invisalign.” *Id.* at 39–40. Further, we are persuaded that “because the detected edges of the aligner and teeth correspond to the edges of the physical objects depicted,” a person of ordinary skill in the art “would have understood that measuring the distance between the outlines of the teeth and the aligner as detected by Salah’s image processing software would allow determination of the gap

between each tooth and the corresponding part of the aligner.” *Id.* at 40 (citing Ex. 1002 ¶ 104).

(d) Whether Time and Expense Weigh Against Motivation

Patent Owner argues that implementing Maninis’s deep learning architecture to assess aligner images would necessitate a significant amount of time and expense, which would weigh heavily against any motivation offered by Petitioner. PO Resp. 62–63. In particular, Patent Owner argues that Dr. Foroosh states that Maninis’s neural network would have been trained on more than 10,000 images of patient’s teeth with seated aligners captured with cellphones, but Petitioner “has identified no such collection of images that existed in 2017.” *Id.* at 62 (citing Ex. 1002 ¶ 100; Ex. 2048, 103:23–106:5, 109:3–19, 222:7–12; Ex. 2028 ¶¶ 138–140; Ex. 2030 ¶ 87; Ex. 2010, 8; Ex. 2041; Ex. 2054, 154:3–12). Patent Owner argues that, because “none of Kim, Invisalign, or Salah discloses photographing seated aligners using a cellphone . . . they could not be used to generate such a learning base.” *Id.* at 63 (citing Ex. 2028 ¶¶ 91, 203). And Patent Owner argues that, if a dentist began capturing such images, they would need to be anonymized and labelled, which a person of ordinary skill in the art would understand to be challenging and expensive. *Id.* (citing Ex. 2028 ¶ 140; Ex. 2030 ¶¶ 88–89).

Based on the complete trial record before us, we are not persuaded by Patent Owner’s arguments. Although Patent Owner contends that there is “significant cost and time” associated with creating a learning base, there is little concrete evidence in the record supporting these arguments. For example, Dr. Mongan testifies that “Dr. Kusnoto . . . informed me . . . there

would be a significant expense associated with labeling photographs to create the learning base and also with de-identifying patient data for purposes of privacy laws,” but does not further explain what that “significant cost” is. Ex. 2028 ¶ 140. Dr. Kusnoto testifies that “I know that the cost of anonymization can exceed \$100,000 per practice for datasets that are smaller than the 10,000 at issue here,” “there may be yet further costs and barriers,” and “it could have cost hundreds of dollars per hour for a dental professional to undertake the labeling.” Ex. 2030 ¶¶ 88, 89. Neither Dr. Kusnoto nor Dr. Mongan provides further information on the time involved. Ex. 2030 ¶¶ 88–90; Ex. 2028 ¶ 140).

Patent Owner’s arguments regarding cost and effort, however, do not undermine Petitioner’s persuasive reasoning for the combination, as discussed above. Neither Dr. Mongan nor Dr. Kusnoto testify that a person of ordinary skill in the art would have been deterred by the alleged costs and effort involved when training Maninis’s deep learning architecture to assess aligner images. *See* Ex. 2028 ¶ 140; Ex. 1048 ¶¶ 25–26; Ex. 2030 ¶¶ 87–90. Moreover, the Federal Circuit has held that:

[T]he fact that the two disclosed apparatus would not be combined by businessmen for economic reasons is not the same as saying that it could not be done because skilled persons in the art felt that there was some technological incompatibility that prevented their combination. Only the latter fact is telling on the issue of nonobviousness.

Orthopedic Equipment, Co. Inc. v. U.S., 702 F.2d 1005, 1013 (Fed. Cir. 1983); *see also Grit Energy Solutions, LLC v. Oren Techs., LLC*, 957 F.3d 1309, 1323–24 (Fed. Cir. 2020) (stating that “even if we accept the Board’s factual determination that swapping [the reference’s] components would

result in a more expensive system, that determination, standing alone, is insufficient to reject each of [Petitioner's] arguments as to why a skilled artisan would have been motivated to make the proposed swamp"); *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006) (stating that "a given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine").

(e) Conclusion Limitation 1(b")

After considering the arguments and evidence of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that the combination of Kim, Invisalign, Salah, and Maninis teaches this limitation, and has persuasively explained why a person of ordinary skill in the art would have been motivated to combine Kim, Invisalign, Salah, and Maninis.

d) Conclusion Independent Claim 1

Therefore, we determine that, on the complete record, Petitioner has shown by a preponderance of the evidence that independent claim 1 would have been obvious over the combination of Kim, Invisalign, Salah, and Maninis.

6. Dependent Claims 7 and 14

Petitioner relies on the combination of Kim, Invisalign, Salah, and Maninis to teach the limitations in claims 7 and 14. Pet. 44–50, 54–55. Patent Owner disputes Petitioner's contentions, arguing that Petitioner fails to identify any "tooth attribute value" assigned to the historical images, as recited in claims 7 and 14. PO Resp. 63.

Limitation “1)” or step 7(1) in claim 7 recites

creation of a learning base comprising more than 1000 images of dental arches, or “historical images”, each historical image representing an aligner worn by a “historical” patient and comprising one or more zones each representing a tooth, or “historical tooth zones”, to each of which, for at least one tooth attribute relating to a separation between the tooth represented by the historical tooth zone considered, and the aligner represented, a tooth attribute value is assigned.

Ex. 1001, 32:47–55. Limitation “1)” or step 14(1) in claim 14 recites the same language. *Id.* at 34:23–31.

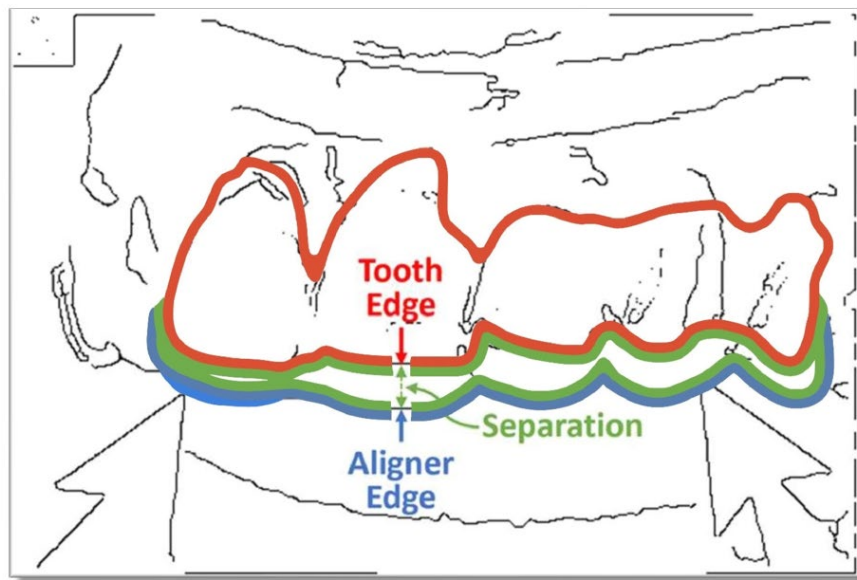
Petitioner contends, among other things, that a person of ordinary skill in the art would have understood that “a large number of images, often far more than 1000, would be typically used to train a deep learning device.” Pet. 45 (citing Ex. 1002 ¶ 122). Petitioner further argues that a person of ordinary skill in the art “would also have used historical ‘images of dental arches’ when adapting Maninis’s contour and detection to the dental imaging apparatus of Kim and Salah,” and “would have used images of patient’s teeth wearing aligners in the training set” to “train a deep-learning-based neural network to recognize teeth, aligners, and their respective edges that delimit the gap between them.” *Id.* (citing Ex. 1002 ¶ 123). According to Petitioner, a person of ordinary skill in the art “would have applied annotations [i.e., Maninis’s ‘pixel-wise semantic annotations’ to indicate which pixels correspond to each object in a given image] to historical dental images to indicate each object’s attributes, including assigning tooth attributes to each tooth in each image, as well as to other parts of the image

including the aligner and the gap separating the aligner and the tooth.” *Id.* (citing Ex. 1002 ¶ 124). Petitioner argues:

With labels to indicate the pixels corresponding to teeth, the pixels corresponding to aligners, and the pixels corresponding to the gap between the two, each historical image would include tooth attribute values assigned directly to the image by the labels. EX1002, ¶¶125-26. For example, *the boundaries between regions would directly indicate the edges of teeth, or of the aligner, both of which are tooth attributes relating to the separation between the tooth and the aligner. Id.* Further, labeling the pixels between each tooth and the corresponding aligner surface (i.e., the gap), the image would include a direct label for the tooth of the separation between the tooth and the aligner—the *labeled gap is literally a label of the separation* to be detected in order to apply Invisalign’s teaching to assess the separation between teeth and the corresponding parts of the aligner.

Pet. 46–47 (emphasis added).

Patent Owner provides an annotated drawing, depicting the boundaries described by Petitioner, which is reproduced below:



PO Resp. 65 (citing Ex. 2028 ¶¶ 209–10) (referring to Ex. 1002 ¶ 103). The drawing above shows teeth, with pixels identified as teeth contours in red, pixels identified as aligner contours in blue, and pixels identified as gap contours in green. *Id.* at 64.

Patent Owner argues that the contours identified by Petitioner define “zones,” not “attributes.” PO Resp. 65. According to Patent Owner, a “tooth zone” corresponds to the “zone” or “location” of a tooth in either the historical or analysis image, whereas the “tooth attribute” is an “attribute” of the tooth represented “on said . . . tooth zone.” *Id.* Patent Owner also argues that “[b]oundaries and edges are also not ‘values’ as required by the claims,” but instead are images (i.e. bitmaps of individual pixel values) that are provided to the neural network as vectors. *Id.* at 65–66 (citing Ex. 2028 ¶¶ 211–214). Therefore, Patent Owner argues, Petitioner has failed to identify any “value” that would have been labelled in the historical image or identified. *Id.* at 66.

In the Reply, Petitioner reiterates that a “labeled gap is literally a label of the separation,” and further argues that Patent Owner ignores the Petition’s explanation that the images would include pixelwise labels indicating “the pixels corresponding to teeth, the pixels corresponding to aligners, and the pixels corresponding to the gap between the two.” Reply 25.

Based on the complete record, we agree with Petitioner that historical images of dental arches with annotated boundaries between regions representing teeth, aligner, and gap contours teach the claimed “tooth attribute values.” As set forth above, the claim language recites “one tooth

attribute relating to a separation between the tooth represented by the historical tooth zone considered, and the aligner represented, a tooth attribute value is assigned.” As cited by Petitioner, the ’248 patent provides a variety of example categories of “tooth attributes.” Pet. 15–16 (citing Ex. 1001, 7:64–8:42, 28:48–55). For example,

Preferably, said tooth attribute is chosen from the group formed by a maximal separation along the free edge of the tooth, a mean separation along the free edge of the tooth

The tooth attribute relating to the separation may in particular be the existence of the separation, this attribute being able to take the tooth attribute values ‘yes’ or ‘no; or a value measuring the scale of the separation, for example an observed maximal separation or an assessment in relation to a scale.

Ex. 1001, 28:48–61 (emphasis added). We find Petitioner’s contentions that “the boundaries between regions would directly indicate the edges of teeth, or of the aligner, both of which are tooth attributes relating to the separation between the tooth and the aligner” (Pet. 47), are consistent with this disclosure. Similarly, Petitioner’s contentions that “labeling the pixels between each tooth and the corresponding aligner surface (i.e., the gap), the image would include a direct label for the tooth of the separation between the tooth and the aligner—the labeled gap is literally a label of the separation,” (Pet. 47), are also consistent with the disclosure in the ’248 patent.

Accordingly, we determine that, on the complete record, Petitioner has shown by a preponderance of the evidence that dependent claims 7 and 14 would have been obvious over the combination of Kim, Invisalign, Salah, and Maninis.

7. Dependent Claim 8

Petitioner relies on the combination of Kim, Invisalign, Salah, and Maninis to teach the limitations in claim 8. Pet. 50–53. Patent Owner disputes Petitioner’s contentions, arguing that Petitioner fails to identify any “image attribute value,” as recited in claim 8. PO Resp. 66–70.

Limitations “1’)” and “3’)” or step 8(1’) and 8(3’) in claim 8 recite:

1’) creation of a learning base comprising more than 1000 images of dental arches, or “historical images”, each historical image comprising an attribute value for at least one image attribute, or “image attribute value”, the image attribute relating to a separation between the tooth or teeth and the aligner represented on the historical image;

...

3’) submission of the analysis image to the deep learning device for it to determine, for said analysis image, at least one probability relating to said image attribute value.

Ex. 1001, 33:3–15.

For limitation “1’),” Petitioner presents similar arguments as for claim 7, but argues that Maninis teaches pixel-wise annotations of all objects in each image of its training database, and as combined with Kim, Invisalign, and Salah “each image would have an aligner and teeth represented in the image, with annotations indicating the regions containing each tooth and corresponding aligner portion, as well as indicating the separation between each tooth and corresponding aligner part.” Pet. 51 (citing Ex. 1007, 5–6; Ex. 1002 ¶ 139). Petitioner contends that “[b]y annotating the images with an aligner (where present) or gap (where present), the image would be annotated with (and thus comprise) image attributes relating to the recited

separation” of the teeth and the aligner. *Id.* at 52 (citing Ex. 1002 ¶ 140). Thus, argues Petitioner, “the set of annotations would collectively represent an image attribute value as claimed, as they would indicate whether the aligner in the image was well or poorly fitted, under the standard taught by Invisalign.” *Id.* For limitation “3’),” Petitioner argues that the probabilities determined by Maninis to detect boundaries between regions and enable identification of objects visible in those regions relate to the image attributes, such as the presence of an aligner and a gap between teeth and aligner, a determination of the distance between the teeth’s edges and the corresponding edges of the aligner, and an indication of a good fit or a poor fit according to Invisalign’s teachings. *Id.* at 53.

Patent Owner argues that the “image attributes” in step 8(1’) and step 8(3’) have to be the same, and none of the “image attributes” identified by Petitioner are “image attributes” within the meaning of claim 8. PO Resp. 67–70.

Based on the complete record, we agree with Petitioner that presence of an aligner or the presence of a gap between the aligner and the teeth, each of which relates to a dental arch image as a whole, teach the claimed “image attribute value.” The ’248 patent discloses that “the value of the image attribute relates to the whole image and not to part of the image,” “[a] tooth attribute value may be used to define a value for an image attribute,” and “an attribute value of the analysis image is determined as a function of the tooth attribute values.” Ex. 1001, 3:24–62, 26:3–4. The ’248 patent also discloses that the “image attribute is chosen from the group formed by a maximal separation along all of the teeth represented, a mean separation along the

free edges of all of the teeth represented, an overall acceptability of the separation of the teeth represented.” *Id.* at 28:51–54; Ex. 1002 ¶ 67. As cited by Petitioner (Pet. 52), the ’248 patent discloses that “[t]he attribute value of the analysis image may also be, for example, the ‘presence’ or ‘absence’ of a dental, preferably orthodontic, appliance.” Ex. 1001, 26:10–14. Although Patent Owner argues that this refers to a “regional” attribute, not an “image” attribute (PO Resp. 67), the plain language of the text conflicts with Patent Owner’s assertions, and neither Patent Owner nor Dr. Mongan provides further explanation on this point. Ex. 2028 ¶ 219. Moreover, as recited in the claim language, the “the image attribute” may relate “to a separation between the tooth or teeth and the aligner represented on the historical image.” Ex. 1001, 33:6–9.

Given these disclosures in the ’248 patent, we are persuaded that Dr. Foroosh’s identification of the presence of the aligner or presence of a separation as image attribute values is consistent with the ’248 patent, and the values for these attributes are reflected in the annotations. Ex. 1002 ¶ 140. We are also persuaded by Dr. Foorosh’s testimony that the locations of each tooth and corresponding aligner part would also be image attributes, because they relate to the tooth-aligner separation, and that the annotation of gaps between the aligner and tooth would indicate attribute values. *Id.*; see Ex. 1001, 3:59–62. We do not find persuasive Patent Owner’s argument that Petitioner’s identified “image attributes” in limitation “1”)” and limitation “3”)” are different. Although Petitioner does not use identical language, Petitioner relies on the “presence of an aligner and a gap between teeth and aligner, as well as a determination of the distance between the teeth’s edges

and corresponding edges of the aligner, and whether this indicated a good fit or a poor fit according to Invisalign’s teachings.” Pet. 53 (citing Ex. 1002 ¶¶ 142–143). This is consistent with Petitioner’s identification for limitation “1’).”

Moreover, we are not persuaded by Patent Owner’s arguments that Maninis cannot be trained on historical images labeled with an “image attribute value,” (PO Resp. 68–70) for the same reasons discussed in Section III.D.5.c.3.a, addressing Patent Owner’s inoperability argument.

Accordingly, we determine that, on the complete record, Petitioner has shown by a preponderance of the evidence that dependent claim 8 would have been obvious over the combination of Kim, Invisalign, Salah, and Maninis.

8. Remaining Claims

Petitioner contends that the combination of Kim, Invisalign, Salah, and Maninis teaches the additional limitations of dependent claims 2, 4, 13, 15, and 16 and, in support, identifies certain passages and figures in the references and explains their significance with respect to the corresponding limitations. Pet. 41–44, 53–59. Patent Owner does not separately challenge these contentions. *See generally* PO Resp. We have reviewed Petitioner’s contentions, which we find persuasive and adopt as our own. Therefore, we determine that Petitioner has also shown those dependent claims to be unpatentable by a preponderance of the evidence. *Id.*

IV. CONCLUSION²⁴

For the foregoing reasons, we are persuaded that Petitioner has established by a preponderance of the evidence that claims 1, 2, 4, 7, 8, and 13–16 of the '248 patent are unpatentable.

Claims	35 U.S.C. §	References/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 2, 4, 7, 8, 13–16	103	Kim, Invisalign, Salah, Maninis	1, 2, 4, 7, 8, 13–16	

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1, 2, 4, 7, 8, and 13–16 of the '248 patent have been shown to be unpatentable; and

FURTHER ORDERED that Patent Owner's Motion to Exclude (Paper 34) is *denied*; and

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

²⁴ 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).

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