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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ALIGN TECHNOLOGY, INC.,
Petitioner,

v.

DENTAL MONITORING SAS,
Patent Owner.

Case No. IPR2023-01369
Patent No. 10,755,409

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE

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I. INTRODUCTION

The petition established that the claims of the '409 patent were obvious over the teachings of the prior art, as illustrated by Salah, Carrier, and Maninis.¹

In response, Patent Owner ("PO") concocts numerous purported obstacles to the proposed combination, makes no effort to solve them, and declares them unsolvable. PO also proposes claim constructions and an alternative level of skill that do not materially affect patentability, raises unpersuasive challenges to prior art status, and misinterprets both the claims and the petition. As discussed below, none of PO's arguments have merit.

II. LEVEL OF SKILL

PO proposes its own level of skill but asserts that it is "not materially different" than Align's. POR, 4-6. Thus, PO's proposal does not undermine the obviousness of the '409 patent's claims.

Nonetheless, PO proposes to dismiss Dr. Foroosh's opinions because he did not consult a dental professional, despite the claims being directed to image analysis, and despite acknowledging Dr. Foroosh's experience with dental image

¹ As PO admits, claim 12 of the '409 patent was held ineligible in district court. POR, 4 n.2. PO subsequently stipulated that this holding also applies to claims 1 and 7. EX1050.

analysis. *Id.* As discussed below in more detail, Dr. Foroosh did not misinterpret the references. *Infra* §§V.A-B.1.

Further, Dr. Mongan’s reliance on Dr. Kusnoto is inconsistent at best—he cites to Dr. Kusnoto’s declaration yet claims never to have seen it, and refers to undisclosed conversations with Dr. Kusnoto while elsewhere providing opinions allegedly derived from Dr. Kusnoto without mentioning him. *See* EX1037, 14:21-15:2, 16:4-10, 80:3-24, 82:9-83:19. Moreover, Dr. Mongan did not rely on Dr. Kusnoto for his first declaration, undermining PO’s assertion that dental practitioner perspective is essential. *See generally* EX2002; EX1037, 29:9-19 (no memory of consulting Dr. Kusnoto prior to first declaration).

Regardless, to address certain issues raised in the POR, Dr. Foroosh has reviewed declaration testimony of Dr. Maureen Valley, a dental professional. EX1048, ¶¶1-9; EX1035, ¶¶1-10; EX1036.

III. CLAIM CONSTRUCTION

PO proposes constructions for three terms, but none of them undermine the petition’s unpatentability arguments.

First, whether “deep learning device” refers to a physical device that employs trained software for image analysis or, as PO argues, to the software itself (POR, 13-15) is of no moment. Image analysis software, such as the neural network architecture discussed in the petition, runs on a physical device, and PO

does not argue that the claims restrict the software of the recited deep learning device to running on the image acquisition device, as opposed to encompassing a separate device performing some or all of the image analysis steps. EX1048, ¶¶13-16.

Second, PO's construction of "real time" does not affect unpatentability of claim 14. PO argues that "analysis and checking occur 'immediately,' while the image acquisition process is still underway." POR, 15. Dr. Mongan confirmed that "immediately" does not "establish[] any specific time duration" and must simply provide useful feedback "soon enough to be part of the acquisition process." EX1037, 62:10-63:11. As the feedback discussed in the petition was provided during the acquisition process—either guiding acquisition or telling a user whether an additional image must be taken—PO's construction of real time does not undermine unpatentability. *See* Pet., 37-41; EX1048, ¶17.

Third, PO proposes a construction of "tooth shape parameter" in claim 4. POR, 16-17. However, PO does not dispute the petition's obviousness showing for claim 4, beyond issues raised regarding claim 1. *See* POR, §VIII. Moreover, "tooth shape parameter" is one alternative in a list of tooth attributes, and the petition demonstrated obviousness for several others, including tooth number and type. *See* Pet., 35, 42, 48. Accordingly, claim 4 is unpatentable regardless of PO's proposed construction. *See Real Time 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.’” (alteration in original) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

IV. CARRIER AND MANINIS ARE PRIOR ART

The POR argues that Carrier and Maninis are not prior art; however, PO’s arguments fail as a matter of law and fact.

A. Carrier

PO asserts Carrier is not prior art because its provisional fails to support its published claims. POR, 24-25. Under *Penumbra, Inc. v. RapidPulse, Inc.*, a patent document is prior art under AIA §102 as of its provisional application’s filing date so long as it meets “the ‘ministerial requirements’ of §§ 119 and 120” and the provisional application “‘describe[s] the subject matter’ relied upon in the reference patent document.” IPR2021-01466, Paper 34 at 32 (Mar. 10, 2023) (precedential, §II.E.3). PO does not dispute that these requirements are satisfied. Nor does PO argue *Penumbra* is inapplicable or wrongly decided. Accordingly, PO’s argument fails as a matter of law.

Further, even if it were necessary to demonstrate that the Carrier Provisional supports claim 1 of Carrier, PO fails to rebut the petition showing. PO argues the Carrier Provisional fails to disclose “a mobile application on a mobile device”

which guides the patient to obtain dental images. POR, 24-25. Specifically, PO asserts that the “user” of the cell phone described in the Carrier Provisional is exclusively a dental professional, never a patient. *Id.*

PO’s argument is inconsistent with the Carrier Provisional, which describes adapting “a user’s own handheld electronics apparatus having a camera (e.g., smartphone)” to guide imaging using an “overlay,” and in the immediately following paragraph it describes that the overlay “may be customized to the user’s teeth.” EX1006, ¶¶53-55; *see also id.*, ¶62 (again referring to patient as user).

There is no dispute that the “user” in paragraph 55 refers to the patient, not a dental professional. *See* EX1037, 92:8-93:12; EX2030, ¶75. Dr. Mongan’s attempts to avoid this disclosure strain credulity. *See, e.g.*, EX1037, 95:24-96:5 (Paragraph 55 describes user, but “I’m not sure what they’re a user of.”), 96:23-97:10 (speculating “user” might refer to “person on whom the acquisition device is used”), 98:14-99:12 (inferring limiting definition from list of examples). Similarly, Dr. Kusnoto admits that the “Carrier Provisional uses the term ‘user’ in a context where ‘user’ implies ‘patient’ and that “[t]he user takes the pictures.” EX2030, ¶75; EX1038, 72:11-15. Thus, both of PO’s experts concede that Carrier discloses that the user—who is guided to take the photos—can be the patient. A dental practitioner would thus agree that Carrier discloses that its user may be a patient, and is not exclusively a dental professional. EX1048, ¶18-22; EX1035, ¶¶22-35.

B. Maninis

PO concedes that Maninis was submitted to arXiv.org for publication on April 28, 2017, over two months before the '409 patent's earliest claimed priority date. POR, 35. Contrary to PO's assertion, the evidence showing arXiv.org's practice and express intent to publish is neither unauthenticated nor inadmissible hearsay. See Pet., 10-11; EX1022; EX1030; EX1031; EX1002, ¶¶65; *see also* EX1023 (no modification after announcement); EX1026 (same); *Constant v. Advanced Micro-Devices, Inc.*, 848 F.2d 1560, 1569 (Fed. Cir. 1988) ("Evidence of routine business practice can be sufficient to prove that a reference was made accessible before a critical date."). And PO offers no rebuttal to Dr. Foroosh's testimony confirming his personal knowledge of arXiv.org's routine practice at the time. See EX1002, ¶¶62-67; *cf. Cooler Masters Co. v. Aavid Thermalloy LLC*, IPR2019-00337, Paper 49 at 30, 37-38 (testimony of routine practice of Japanese Patent Office sufficient to establish publication).

PO speculates that there may have been some delay in publication but offers no evidence suggesting any deviation from typical practice occurred. POR, 35-37. PO also does not address the Wayback Machine archive of an arXiv.org search page providing a direct download link for the Maninis PDF prior to July 21, 2017, nor Dr. Foroosh's testimony that metadata indicates a creation date consistent with publication according to arXiv's policies. See EX1025; EX1031; EX1002, ¶¶66.

V. CLAIMS 1-15 ARE UNPATENTABLE AS OBVIOUS OVER SALAH, CARRIER, AND MANINIS

The POR addresses only independent claim 1 and dependent claims 7-9 and 14. As discussed below, PO fails to rebut the petition's showing of obviousness for any challenged claim.

A. PO Mischaracterizes the Proposed Combination

PO characterizes the petition as having proposed a combination of Carrier, Salah, and the "Maninis COB neural network." POR, 37-39. PO then asserts that the COB neural network is incapable of being used to achieve the outcomes described in the petition, allegedly undermining motivation to combine and rendering the combination inoperable. POR 39-42. However, the petition materials never used the term "COB neural network." As Dr. Mongan admits, he introduced the term to act as a synonym to a "COB" component discussed in part of Maninis. *See* EX1037, 104:11-19, 107:2-17; *see also* 103:14-104:10 (admitting that although Dr. Foroosh does not use the term, Dr. Mongan equates Dr. Foroosh's reference to "Maninis" with what Dr. Mongan calls "Maninis's COB neural network"); EX1038, ¶¶23-25. Indeed, Dr. Mongan admits that his term "COB neural network" *excludes* the disclosure in Maninis of "coupling COB with different networks or different pipelines that are not themselves COB." EX1037, 118:13-119:11; *see also* POR, 27-32 (interpreting "COB neural network" to

exclude Maninis's teaching (EX1007, 11-13) to use COB as an element of an object detection pipeline).

This is not a trivial distinction, as the petition expressly and repeatedly relied on the teachings of Maninis that PO excludes from consideration. The petition repeatedly cites to that section of Maninis (section 6, pages 11-12) when explaining that Maninis uses neural networks not only to detect contours, but also uses the regions identified by those contours to classify objects. *See, e.g.*, Pet., 11, 22, 23, 33-34 (each citing EX1007, 11-12); EX1002, ¶¶68, 83, 85, 116-17. Pointing to the techniques Maninis discloses to identify and classify objects, the petition argued that "a POSA would have been motivated to use those techniques to implement Carrier's 'image recognition algorithms' to detect specific teeth bounded by the detected contours." Pet., 34; EX1002, ¶118; EX1048, ¶¶25-26.

By excluding those teachings from consideration, PO leaves the petition's actual argument unaddressed, attacking instead a strawman. This defect pervades the POR, as it repeatedly advances arguments regarding what "Maninis's COB neural network" can or cannot do, rather than addressing the teachings of Maninis relied on by the petition. *E.g.*, POR, 1, 27, 29-32, 38-41, 49. Because it does not address the petition ground, PO's argument fails. EX1048, ¶¶27-28.

PO also suggests that Maninis's teachings regarding object classification must be ignored because Maninis refers to known techniques first "described by

different authors in *different* papers.” POR 2, 41 (emphasis original). Yet this does not negate the fact that Maninis expressly describes using those prior art techniques. *See also Gen. Elec. Co. v. Raytheon Techs.*, 983 F. 3d 1334, 1352 (Fed. Cir. 2020) (improper to “dissect[] prior art references into collections of individual elements, requiring a party showing obviousness to re-do the work already done in the prior art reference”). Indeed, Maninis provides more detail regarding object classification than the ’409 patent. *Cf. SRI Int’l, Inc. v. Internet Sec’y Sys., Inc.*, 511 F.3d 1186, 1194 (Fed. Cir. 2008) (lower enablement standard for prior art met where disclosure in specification no better); *compare* EX1007, 11-12 (detailed explanation of use of various algorithms, including neural networks, for semantic boundaries and object classification), *with* EX1001, 16:13-50 (listing names of “networks specializing in the location and detection of objects in an image” without further details). PO cites no authority requiring submission of earlier references introducing the techniques taught by Maninis; indeed, any such requirement would lead to an endless recursion of cited references being submitted.

While PO’s arguments can be rejected as falsely premised on excluding Maninis’s object classification teachings, PO also attacks Dr. Foroosh’s credibility by arguing he did not understand Maninis. *See* POR, 40-41. In the cited portion of Dr. Foroosh’s deposition testimony, he was asked whether the “the results reported

in Table 3” of Maninis included “object recognition,” and specifically identifying “contours or boundaries as associated with a particular object.” EX2048, 211:20-212:15.² As he correctly answered, they do—that section of Maninis discloses performing “object boundary detection” for which “detections are focused on the 20 object classes,” and resulting boundaries of detected objects are shown in the last row of Fig. 10. *See* EX1007, 7-9, Fig. 10; EX2048, 131:22-132:11 (agreeing that in Fig. 10, two sheep have been detected as two objects). Thus, Dr. Foroosh correctly testified that the boundaries were associated with a particular object—even if the assignment of the object’s label occurs in the subsequent step of analysis. *See* EX1007, 9-12 (using COB as object proposals to generate semantic boundaries).

B. POSAs had Reason to Combine Salah, Carrier, and Maninis

PO raises several arguments challenging whether POSAs would have combined Salah Carrier, and Maninis, but each fails, as discussed below.

1. The Petition Materials Support Rationale to Combine

PO suggests that Dr. Foroosh identified no rationale to combine the prior art and relied on hindsight. POR, 43-44. Neither his declaration nor his deposition bears this out.

² A version of this transcript with errata is provided as EX1049.

First, Dr. Foroosh's declaration clearly laid out reasons to combine each reference. *See, e.g.*, EX1002, ¶¶81 (combining Carrier and Salah based on "complementary teachings" to allow one to "effectively assess alignment based on the appearance of the patient's teeth, thereby ensuring high-quality dentition images"), 84 (POSA led to further add Maninis based on Carrier's teaching to use appropriate edge detection techniques and image recognition, Salah's express suggestion to use deep learning for edge detection in dental images, and matching trends in field), 85-86 (further reasons to combine including achieving better, and faster, state-of-the-art results when providing alignment taught by Salah and Carrier). PO fails to rebut these motivations, as discussed further below in §§V.B.2-3.

Second, PO's hindsight arguments are unfounded. Not only did Dr. Foroosh's declaration provide specific, non-hindsight reasons to combine the grounds references, but PO's citation to the deposition transcript is misleading. For example, Dr. Foroosh explained that the POSAs' objectives would not be obtained from the '409 patent but instead from the three prior art references raised in the ground. EX2048, 227:10-229:13. ("I'm not saying that the person of ordinary skill would say, okay, let me achieve [the '409 patent claims]."). Thus, far from employing hindsight, Dr. Foroosh explained that the teachings of the prior art

would have led POSAs to practice the claimed method for similar reasons to those reflected in the '409 patent.

2. POSAs Had Reason to Use Carrier's Alignment Techniques

PO contends that POSAs would have preferred to used Salah's "registration marks" instead of Carrier's technique of aligning based on teeth. POR, 45-48. PO's reliance on Salah's expression of preference (POR, 47) to defeat obviousness is legally unsound. *E.g.*, *In re Fulton*, 391 F.3d 1195, 1200 (Fed. Cir. 2004) (no requirement that combination be preferred); *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994) (combination obvious despite being described as inferior).

Furthermore, PO's arguments (POR, 46-47) for registration marks' superiority fall flat. Registration marks would be less reliable than Carrier's alignment to teeth edges, both because registration marks provide fewer pixels (reducing alignment reliability) and because they can move substantially relative to the teeth. EX1048, ¶¶29-33; EX1035, ¶¶43-44. Indeed, the teeth naturally provide the most accurate basis to align an image of *themselves*. EX1048, ¶32. Variations in patients' teeth, either patient-to-patient or over time due to treatment are also a red herring. Carrier expressly teaches using patient-specific overlays that account for predicted or actual tooth movement, eliminating any concern in this regard. EX1006, ¶64; EX1005, ¶109; EX1048, ¶¶34-37; EX1035, ¶¶41-42; *see* EX1038, 78:10-21 (movement of 0.5-1 mm per month at most). Additionally, Salah's

registration marks would require capturing the parts of the retractor containing the marks (see EX1008, Fig. 5A (marks at corners); EX1037, 69:9-20 (corners would need to be captured); EX2030, ¶90 (showing marks at corners). This would reduce the useful pixels depicting patient teeth relative to Carrier. See EX1048, ¶¶38-39; EX1006, Fig. 7B (aligning with closer image); EX1005, Fig. 7B.

Accordingly, PO's arguments against combining Carrier and Salah fail.

3. POSAs Had Reason to Combine Maninis with Carrier and Salah

PO asserts that Maninis offers no benefit, would render analysis too slow, and would entail too much expense to use in capturing dental images as taught by Salah and Carrier. POR, 49-57. None of these arguments passes muster.

i. POSAs Would Have Expected Benefits from Maninis's Techniques

PO's arguments against Maninis's benefits fall flat. POR, 49-51.

PO suggests (POR, 50) that Salah's identification of deep learning as a non-preferred option would undermine motivation, but this repeats the legal error discussed above in §B.2. See *Fulton*, 391 F.3d at 1200; *Gurley*, 27 F.3d at 553.

PO also speculates (POR, 50-51) that the improvements realized in Maninis might not provide similar improvements when performing a similar function in the proposed combination. But Maninis would be providing functions taught in Carrier and Salah for image alignment (such as edge detection and object classification),

and PO gives no reason that the improvements in these functions would not carry over to the application in the proposed combination. Pet., 23-24, 30, 33-35.

Further, while PO mentions “contour detection” accuracy, it entirely ignores Maninis’s further reported improvements in semantic segmentation and object classification. See Pet., 11, 23; POR, 50-51; EX1007, 11-12, Tables 4-7 (improved performance when using COB in object classification pipeline); EX1037, 144:2-145:9 (semantic segmentation using COB achieved “higher score on the metric they were using” for accuracy, including greater boundary precision).

PO also argues that improvements in accuracy deriving from combining the references would be irrelevant, as Salah and Carrier teach that “image alignment need only be approximate.” POR, 51. Nothing in Carrier’s teaching that approximate alignment can suffice in some circumstances undermines the desirability of high-quality images. Indeed, Carrier expressly teaches the desirability of “obtaining high quality dental images” including images in which 90 percent of its overlay is aligned to within 0.1 mm accuracy. EX1006, ¶¶5, 54-55, 63; EX1005, ¶¶5, 99-100, 108; EX1002, ¶¶49, 112. Salah likewise discusses filtering out images not meeting a quality threshold, confirming that image quality is desirable. EX1008, 60:14-29. PO does not dispute that the teachings of Maninis would improve the image acquisition taught by Salah and Carrier, including by

enhancing image alignment with improved edge detection taught by Maninis. *E.g.*, Pet., 23-24; EX1002, ¶86.

Finally, PO's further arguments regarding costs and appropriateness of Maninis fail as discussed below in §§V.B.3.ii-iii.

ii. Maninis's Techniques are Compatible with Real-Time Feedback

PO argues that the use of deep learning image analysis, as taught by Maninis, would be incompatible with providing real-time feedback on a mobile phone. POR, 51-54. PO's argument applies limitations absent from the claim and not advanced in the petition, treats the POSA as an automaton, and holds the prior art to a higher standard than the '409 patent.

To begin with, the claims do not recite that the "deep learning device" must be embodied in the "image acquisition device," much less that it be part of a cellphone. Even PO's construction merely specifies that the deep learning device refers to software—it does not specify where it must be run. Since the claims are agnostic to whether the deep learning device is present on a cell phone or in communication with a cell phone, the petition presented a combination consistent with either implementation choice. As Dr. Foroosh explains, implementing a deep learning device separately from the image acquisition device would be a

straightforward, predictable option known to the POSA, and would eliminate the “real-time” concerns raised in the POR. EX1048, ¶¶40-42.

However, PO’s arguments that real-time feedback would be impossible fail even if the deep learning device were implemented on a cell phone. PO provides time estimates for the feedback discussed in the petition, claiming that “analysis could take more than 6 seconds,” or even twice that long. POR, 53-54. However, this estimate results from a back-of-the-envelope calculation that assumes Maninis’s full neural network architecture would be run directly on a cellphone, without any adaptation to run on such a platform. EX1048, ¶¶43-44. This treats the POSA as an automaton, ignoring routine optimization steps that would have been employed when adapting a neural network architecture for use on a mobile device. *Id.*

For example, it was well known that trained neural networks could be made substantially more efficient and less processor-intensive. One example is the process of converting neural networks into sparse neural networks, which by 2015 was known to increase efficiency by a factor of five to ten times with accuracy reduction as low as 1 percent. EX1048, ¶43 (citing EX1039, Abstract, 806, 813). This reduction alone would eliminate the concerns raised by Dr. Mongan. *See id.*, EX2028, ¶¶141-44. Because Dr. Mongan ignores techniques that POSAs would have employed to reduce computational burden, he substantially overstates the

time required to use neural networks on cellphones. See EX1048, ¶¶43-44 (citing EX1039; EX1040, Abstract, 2; EX1041, 1-2, 6-7, Table 8). Taking such techniques into account, a POSA would not be deterred by concerns of delayed feedback. *Id.*

Moreover, Dr. Mongan ignores the realities of software development. As Dr. Foroosh explains, concerns that a particular implementation might be somewhat too resource-intensive would not have discouraged a POSA when developing such software, as it was a longstanding trend that mobile devices like cellphones would increase exponentially in computing capacity. POSAs thus typically developed software with the expectation that it would be running on the more powerful devices being developed at the same time. This trend is borne out in PO's own evidence, showing that the next model of iPhone (the XS) had ten times the neural network processing power as the 2017 model of iPhone released the year before. EX1048, ¶46; EX2043, 9; EX1046 (XS released in 2018).

PO and Dr. Mongan speculate that the semantic class identification part of Maninis might take "significantly longer," but offer no supporting reasoning or documentation. POR, 34, 54; EX2028, ¶144. In fact, the Fast R-CNN classifier used by Maninis classifies images in as little as 60 ms. EX1048, ¶47 (citing EX1042, Table 4). Indeed, Maninis discloses the same neural networks as the '409 patent, undermining PO's argument that the deep learning techniques taught by

Maninis would be infeasible for the analysis claimed in the '409 patent. EX1048, ¶¶45, 47 (citing EX1007, 11-12, 14; EX1001, 16:36-41).

Even if PO's inflated time estimates were accurate, such delay would still be consistent with the claims and would not undermine motivation to combine. For example, the petition proposed providing feedback to tell users to re-take a photo. *See* Pet., 37-41. This feedback comes during image acquisition (and is thus real-time under PO's construction) and some delay to analyze the image would not undermine its function. EX1048, ¶¶48-49. Further, to the extent delay was a concern for the edge-detection aspects of the combination (e.g., overlay alignment), Maninis teaches providing outputs at earlier stages of processing (corresponding to finer features), which a POSA would find sufficient to perform those functions while taking less time. *Id.*

Finally, PO applies an inconsistent standard to attack the proposed combination. The '409 patent relies on deep learning generically, while offering no teachings to produce more rapid results. EX1048, ¶45. PO's argument that the claims are patentably distinct from the prior art without any disclosure remedying the prior art's alleged deficiency is simply untenable.

iii. Costs Would Not Have Deterred POSAs

PO suggests training costs would have deterred POSAs from using deep learning as taught in Maninis. POR, 55-56. These economic arguments cannot

rebut the petition's showing of obviousness, as they raise no issue of technological feasibility. *See Orthopedic Equip. Co. v. United States*, 702 F.2d 1005, 1013 (Fed. Cir. 1983). The arguments also fail on their own terms, as not only are the cost estimates exaggerated, but even if accurate they would not meaningfully discourage POSAs.

First, PO's cost estimates are exaggerated. PO asserts that image anonymization would impose costs, but Dr. Kusnoto admitted that his estimate (\$1.5 million) included the costs of several steps not required for images of teeth like those discussed in the petition, such as redaction and adding labels beyond tooth numbers. EX1038, 86:24-90:23; *see id.*, 88:16-21 (additional labels), 81:20-25 (redaction of image of teeth unnecessary). Likewise, his two-year time estimate was premised on part-time labor of five to ten hours per week, and even accepting his time and wage estimates, the cost would be about \$200,000, far short of his \$1.5 million estimate. *See* EX1038, 90:1-20 (10,000 images, three images per hour, \$60 per hour = \$200,000). Further, to the extent costs were a concern, various cost-saving measures were well-known to POSAs. EX1048, ¶¶50-54 (citing EX1043, 26; EX1044, Abstract, 3-4; EX1047, 373-74, 381-83). PO ignores any such measures. The POR also identifies nothing in the '409 patent teaching improved cost-savings relative to the state of the art.

Moreover, even presuming PO's cost estimates accurate, such costs would not have deterred a POSA, as those estimates are quite low. Dr. Mongan estimates the total relevant costs at merely "tens of thousands to hundreds of thousands of dollars," while Dr. Kusnoto estimates \$1.5 million. EX2028, ¶149; EX2030, ¶49. A POSA would have viewed such costs as acceptable when developing a deep learning device, and PO fails to explain why POSAs would be deterred by them. EX1048, ¶¶55-56.

C. PO's "Required-Teeth" Arguments Fail

PO argues that a POSA would not be motivated by the teachings of Salah, Carrier, and Maninis to detect the visibility of required teeth. POR, 57-59. This not only fails to address the full scope of the combination, but it also relies on a misreading of Carrier, as confirmed by both Dr. Foroosh and Dr. Valley.

As an initial matter, PO's argument only applies to one of the two examples of image attribute detection discussed in the petition. It does not impact use of edge detection for image alignment. *E.g.*, Pet., 32. The argument thus cannot suffice to undermine the petition's showing of obviousness.

In any event, PO's arguments that a POSA would not be motivated to detect whether required teeth are visible fail. In addition to guiding the user to align and capture an image, Carrier discloses "check[ing] the image quality of the captured image," including, in some embodiments, "using image recognition algorithms to

ensure that all required teeth are visible.” EX1006, ¶¶80-81; EX1005, ¶¶126-28.

PO asserts this does not involve comparing a set of required teeth to the teeth visible in an image using image recognition; rather, PO suggests that this disclosure is concerned *only* with “approximate alignment of the ‘view,’ not the presence or number of specific teeth.” POR, 57-59.

PO’s interpretation does not comport with Carrier’s disclosure. Carrier discusses the image recognition algorithms used to ensure all required teeth are visible in the context of image quality assessment of images captured after having been aligned to the patient’s teeth. As Dr. Kusnoto admits, Carrier discloses a set of teeth intended to be captured for each predetermined viewpoint—that is, the “required teeth.” EX2030, ¶¶64, 78; EX1038, 58:8-61:2 (overlay indicates set of teeth required for the view, such as six particular teeth). Both of PO’s experts concede that even if the image is aligned properly, some required teeth (i.e., intended teeth for the viewpoint) may not be visible. EX1038, 61:4-23; EX1037, 73:17-25, 79:6-80:1. Thus, determining whether all required teeth are visible is a technique to assess whether the aligned image actually shows all teeth intended for that viewpoint. EX1048, ¶¶57-63; EX1035, ¶¶36-38.

Dr. Kusnoto tries to avoid the logical conclusion that Carrier teaches to check for the visibility of each required tooth by claiming that in a view with six required teeth, if one tooth were obstructed, then the five visible teeth would be the

“required teeth” instead. EX1038, 61:4-62:24. This is simply unreasonable, stripping Carrier’s teaching “to ensure that all required teeth are visible” of any meaning. If “required teeth” meant whatever teeth were actually visible, any image would have all required teeth visible by definition, eliminating the function of the image recognition software taught by Carrier. The reality is that Carrier means just what it says when it describes using image recognition algorithms to detect whether all required teeth are visible, and based on Carrier’s disclosure, read in context with Salah and Maninis, a POSA would make use of a deep learning device to do so. EX1048, ¶¶63-64; EX1035, ¶¶36-38.

PO tries to avoid this teaching by pointing out that some patients may be missing teeth, such that the “required teeth” might vary. POR, 57-58. But the disclosure PO points to (EX1006, ¶60; EX1005, ¶105) answers the question PO raises—the overlay “shows what teeth should be visible” (providing the “required teeth” for the viewpoint). And Carrier expressly teaches that the overlay can be “a patient-specific overlay derived from the patient’s teeth.” EX1006, ¶62; EX1005, ¶107. If a patient had a missing tooth, the set of required teeth (provided by the patient-specific overlay) would be correct for that patient. EX1048, ¶65; EX1035, ¶40. Thus, PO’s argument fails.

D. Claim 7

The petition explained that a dental image with labels of each tooth shown in the image is an image “comprising an attribute value for at least one image attribute” as recited in claim 7, as the labels record the set of teeth in the labeled image. Pet., 50-51. PO argues that such a labeled image does not comprise an image attribute value and that the image attribute value must be labeled as a separate, redundant list distinct from the set of tooth labels. POR, 59-64. This argument fails.

A labeled set of tooth numbers is an image attribute value. Claim 7 imposes no restriction on the format of the recited image attribute value, requiring only that the images *comprise* an attribute value for an image attribute. The specification indicates that a list of tooth attribute values can be an image attribute value. EX1001, 26:16-26. PO points to nothing in the claim or specification distinguishing a list of tooth attribute values from a set of tooth attribute values.

Nor does PO dispute that Maninis teaches labeling images with values indicating each depicted object, nor that such labels would correspond to tooth numbers in the proposed combination. See POR, 59-64; EX1002, ¶¶119 (labeling teeth by number), 176-77 (pixelwise annotations label image attribute value). An image with every depicted tooth labeled by number both *comprises* and *records* such a value by recording the set of tooth numbers in the image’s pixel

annotations. *See* EX1002, ¶¶119, 176-77. Because PO’s argument imports unrecited (and unexplained) restrictions on the format of the claimed image attribute value, it fails.

E. Claims 8-9

PO addresses claims 8 and 9 together and does not contend that any recited element is absent from the prior art. POR, 64-66. Rather, PO asserts that Align identified no motivation to practice claims 8-9 and that there was no evidence regarding whether POSAs would have used computer algorithms in labeling images. These assertions simply ignore the petition materials.

In fact, Align expressly identified reasons to arrive at the recited claims. *See* Pet., 53 (benefits including providing “simple mechanism to connect regions of pixels ... to the ‘ground-truth’” and “leverag[ing] information contained in existing patient dental models to label images”), 60-61 (efficient annotation applying known techniques); EX1002, ¶¶197-99 (straightforward, predictable process providing annotations used by Maninis). These motivations were supported by undisputed testimony from Dr. Foroosh, corroborated by published papers, that the relevant techniques of labeling using registered data from models were known to POSAs. *See* EX1002, ¶¶38, 199 (citing EX1013, 3689-90; EX1014, 3198, 3200-01). The POR ignores this evidence.

PO also asserts that Salah does not disclose that its 3D models label teeth by number (POR, 65); however, this both improperly attacks the references in isolation and takes an unreasonably narrow view of Salah’s disclosure. The petition materials explained that tooth numbering was a long-established method that was obvious to use in the proposed combination. *See* Pet., 35; EX1002, ¶119. PO does not dispute this. Further undisputed is Salah’s teaching to identify a model for each tooth, individually, in an arch model. Pet, 54-55; EX1002, ¶188 (citing EX1008, 23:4-8, Fig. 4d). Nor does PO dispute that “when producing individual models of different teeth, the modeled teeth should be identified (e.g., by tooth number or type),” as was “well known” to POSAs. EX1002, ¶190 (citing EX1009, ¶¶7-8, 12); *see* Pet., 56.

PO lastly speculates that there may be concerns with accuracy, suggesting that humans should supervise labeling. POR, 65-66; *see* EX2028, ¶217 (proposing that a professional review automatically-labeled images). Not only does PO provide no quantification or explanation of this hypothetical issue, but it does not even address the petition’s case—Dr. Foroosh explained that manual adjustment could be used “as needed” when identifying tooth zones to label. EX1002, ¶197; *cf.* EX2028, ¶217 (Dr. Mongan agreeing same). And while Dr. Mongan discusses that some cost may be involved (EX2028, ¶217), PO neither argues this as a basis

for non-obviousness nor discusses any weighing of costs and benefits. *See* POR, 64-66.

F. Claim 14

PO argues that the combination of Salah, Carrier, and Maninis could not provide real-time feedback, despite Salah and Carrier's express teaching to provide real time feedback. POR, 66. However, as discussed above, PO's time estimates grossly overestimate the time needed for analysis. *Supra* §V.B.3.ii. Regardless, PO's construction of "real time" would be met, because the proposed combination still provides feedback during the image acquisition process. *Supra* §III; *see* Pet., 37-41 (feedback while acquiring images). PO's arguments against claim 14 thus fail.

VI. CONCLUSION

For the reasons set forth above, claims 1-15 of the '409 patent are unpatentable and should be canceled.

Respectfully submitted,

Dated: August 20, 2024

/ Michael T. Rosato /
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VII. CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. §42.24(d), the undersigned certifies that this Reply complies with the type-volume limitation of 37 C.F.R. §42.24(c). The word count application of the word processing program used to prepare this Reply indicates that the Reply contains 5,597 words, excluding the parts of the brief exempted by 37 C.F.R. §42.24(c).

Dated: August 20, 2024

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VIII. APPENDIX – PETITIONER’S UPDATED EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 10,755,409 to Salah et al.
1002	Declaration of Dr. Hassan Foroosh
1003	Curriculum Vitae of Hassan Foroosh, Ph.D.
1004	U.S. Patent Application No. 16/031,201 File History
1005	U.S. Patent Pub. No. 2021/0068923 to Carrier et al.
1006	Provisional Patent Application No. 62/417,985 to Carrier et al.
1007	Maninis et al., “Convolutional Oriented Boundaries: From Image Segmentation to High-Level Tasks,” <i>arXiv.org</i> (Apr. 28, 2017)
1008	Translation of PCT Pub. No. WO 2016066651 to Salah et al.
1009	U.S. Patent Pub. No. 2013/0282351 to Martin Tank
1010	U.S. Patent Pub. No 2020/0229901 (Application No. 16/827,594)
1011	U.S. Patent Pub. No. 2018/0125610 (Application No. 15/803,718)
1012	PCT Pub. No. WO 2016066651 to Salah et al.
1013	Xie et al., “Semantic Instance Annotation of Street Scenes by 3D to 2D Label Transfer,” <i>2016 IEEE Conference on Computer Vision and Pattern Recognition</i> (2016)
1014	Chen et al., “Beat the MTurkers: Automatic Image Labeling from Weak 3D Supervision,” <i>2014 IEEE Conference on Computer Vision and Pattern Recognition</i> (2014)
1015	Krizhevsky et al., “ImageNet Classification with Deep Convolutional Neural Networks,” <i>Advances in Neural Information Processing Systems</i> 25 (2012)

1016	Patrick Cavanaugh, “Visual Cognition” <i>Vision Research</i> 51 (2011)
1017	Prasad et al., “Learning Class-specific Edges for Object Detection and Segmentation,” <i>Computer Vision, Graphics and Image Processing: 5th Indian Conference, ICVGIP 2006</i> (2006)
1018	Wang et al., “Simultaneous Image Classification and Annotation,” <i>CVPR</i> 1, No. 2 (2009)
1019	Tao et al., “Similarity Voting based Viewpoint Selection for Volumes,” <i>Computer Graphics Forum</i> 35, No. 2 (2016)
1020	United States District Courts — National Judicial Caseload Profile, available at https://www.uscourts.gov/sites/default/files/data_tables/fcms_na_distprofile0331.2023.pdf (March 2023)
1021	Maninis et al., “Convolutional Oriented Boundaries: From Image Segmentation to High-Level Tasks,” <i>arXiv.org</i> (Jan. 17, 2017)
1022	<i>arXiv.org Submission Help Page</i> , https://arxiv.org/help/submit (as archived May 3, 2017, at https://web.archive.org/web/20170503071322/https://arxiv.org/help/submit)
1023	<i>arXiv.org Article Replacement Help Page</i> , https://arxiv.org/help/replace (as archived July 18, 2017, at https://web.archive.org/web/20170718173822/https://arxiv.org/help/replace)
1024	<i>COB - Convolutional Oriented Boundaries</i> , http://people.ee.ethz.ch/~cvlsegmentation/cob/ (as archived May 3, 2017, at http://web.archive.org/web/20170503233424/http://people.ee.ethz.ch/~cvlsegmentation/cob/)
1025	<i>arXiv.org Author Search Page for Luc van Gool</i> , https://arxiv.org/find/cs/1/au:+Gool_L/0/1/0/all/0/1 (as archived July 8, 2017, at https://web.archive.org/web/20170708002617/https://arxiv.org/find/cs/1/au:+Gool_L/0/1/0/all/0/1)
1026	<i>arXiv.org Article Replacement Help Page</i> , https://arxiv.org/help/replace (as archived September 8, 2016, at https://web.archive.org/web/20160908205209/https://arxiv.org/)

	help/replace)
1027	Joint Stipulation and Proposed Order (Dkt. No. 73), <i>Dental Monitoring SAS v. Align Technology, Inc.</i> , Case No. 3-22-cv-07335 (N.D. Cal., Aug. 30, 2023)
1028	Defendant Align Technology, Inc.’s Stipulation re Challenged Claims in IPR2023-01369 (Dkt. No. 106), <i>Dental Monitoring SAS v. Align Technology, Inc.</i> , Case No. 3-22-cv-07335 (N.D. Cal., Jan. 8, 2024)
1029	Second Declaration of Dr. Hassan Foroosh (served not filed)
1030	Declaration of Nathaniel E. Frank-Wright
1031	Second Declaration of Nathaniel E. Frank-Wright
1032	Intentionally Left Blank
1033	Rajkomar et al., “High-Throughput Classification of Radiographs Using Deep Convolutional Neural Networks,” <i>J. Digital Imaging</i> , 30, 95-101 (Feb. 2017)
1034	Intentionally Left Blank
1035	Declaration of Dr. Maureen Valley
1036	Curriculum Vitae of Maureen Valley, D.M.D., M.P.H., M.S.
1037	Deposition Transcript of Dr. John Mongan (July 23, 2024)
1038	Deposition Transcript of Dr. Budi Kusnoto (Aug. 9, 2024)
1039	Liu et al., “Sparse Convolutional Neural Networks,” 2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (2015)
1040	Wu et al., “Quantized Convolutional Neural Networks for Mobile Devices,” <i>arXiv.org</i> (https://arxiv.org/pdf/1512.06473v3) (May 16, 2016)
1041	Howard et al., “MobileNets: Efficient Convolutional Neural Networks for Mobile Vision Applications,” <i>arXiv.org</i> (https://arxiv.org/pdf/1704.04861v1) (Apr. 17, 2017)

1042	Ross Girshick, “Fast R-CNN,” <i>arXiv.org</i> (https://arxiv.org/pdf/1504.08083v2) (Sep. 27, 2015)
1043	Dong-Hyun Lee, “Pseudo-Label: The Simple and Efficient Semi-Supervised Learning Method for Deep Neural Networks,” <i>ResearchGate</i> (https://www.researchgate.net/profile/Dong-Hyun-Lee/publication/280581078_Pseudo-Label_The_Simple_and_Efficient_Semi-Supervised_Learning_Method_for_Deep_Neural_Networks/links/55bc4ada08ae092e9660b776/Pseudo-Label-The-Simple-and-Efficient-Semi-Supervised-Learning-Method-for-Deep-Neural-Networks.pdf) (Aug. 1, 2015)
1044	Patrini et al., “Making Deep Neural Networks Robust to Label Noise: a Loss Correction Approach,” <i>arXiv.org</i> (https://arxiv.org/pdf/1609.03683v2) (Mar. 22, 2017)
1045	“Apple Presents iPhone 4,” https://www.apple.com/newsroom/2010/06/07Apple-Presents-iPhone-4/ (as archived May 25, 2017, at http://web.archive.org/web/20170525092213/http://www.apple.com/newsroom/2010/06/07Apple-Presents-iPhone-4/)
1046	“iPhone Xs and iPhone Xs Max Bring the Best and Biggest Displays to iPhone,” https://www.apple.com/newsroom/2018/09/iphone-xs-and-iphone-xs-max-bring-the-best-and-biggest-displays-to-iphone/ (as archived Sep. 12, 2018, at http://web.archive.org/web/20180912213153/http://www.apple.com/newsroom/2018/09/iphone-xs-and-iphone-xs-max-bring-the-best-and-biggest-displays-to-iphone/)
1047	Schnitman et al., “Inducing Semantic Segmentation from an Example,” <i>Computer Vision—ACCV 2006</i> (2006)
1048	Reply Declaration of Dr. Hassan Foroosh
1049	Deposition Transcript of Dr. Hassan Foroosh (with errata)
1050	Order Granting Final Judgment Pursuant to Joint Stipulation, <i>Dental Monitoring SAS v. Align Technology, Inc.</i> , Case No. 3-22-cv-07335 (N.D. Cal., Aug. 8, 2024)

CERTIFICATE OF SERVICE

The undersigned certifies that the foregoing Petitioner's Reply to Patent Owner's Response and Exhibits 1030, 1031, 1033, and 1035-1050 were served on August 20, 2024, at the following electronic service addresses:

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