

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. IPR2024-00110
Patent No. 11,109,945

REPLY DECLARATION OF DR. HASSAN FOROOSH

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I, Hassan Foroosh, declare as follows:

I. QUALIFICATIONS

1. I submitted an expert declaration in support of Petitioner Align's petition for *inter partes* review (IPR) of U.S. Patent No. 11,109,945 (the "'945 Patent," EX1001) in Case No. IPR2023-00110. I understand that an IPR was instituted and Patent Owner Dental Monitoring submitted a Patent Owner Response. I submit this expert declaration in support of Align's Reply to the Patent Owner Response.

2. I previously set forth my qualifications in my first declaration (EX1002) at paragraphs 1-13. I also submitted my curriculum vitae (EX1003) at that time, which further sets forth my qualifications.

3. In preparation for this declaration, I have reviewed the Declaration of Dr. John Mongan (EX2028) and the Declaration of Dr. Budi Kusnoto (EX2030). Lists of exhibits I cited in this declaration are provided in the Appendices.

II. LEGAL STANDARDS

4. I understand that my opinions in this declaration require applying the legal principles outlined in my first declaration. As was done previously, I have applied those same legal principles in forming my opinions here.

III. LEVEL OF SKILL IN THE ART

5. I previously set forth my understanding and opinions pertaining to a person of ordinary skill in the art in the relevant field (“POSA”) in my first declaration at paragraphs 60-61.

6. For example, in paragraph 61, I described that as of June 9, 2017, a POSA

would typically have an advanced degree, such as a Masters’ Degree or Ph.D. in computer science or a related field, with at least two years of work in computer vision, image analysis, medical imaging, or related areas. A POSA could have less education but significant professional experience in one or more of these fields. A POSA could be a member of an interdisciplinary team including persons with backgrounds such as electrical engineering, computer science, optical imaging, and dentistry or orthodontics, and could call upon the knowledge of other team members as appropriate.

EX1002, ¶51.

7. I understand that Dr. Mongan has provided an alternative description of the POSA as follows:

In my opinion, a person of ordinary skill in the relevant field as of June 9, 2017 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 image analysis techniques or algorithms. A POSA 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.

EX2028, ¶46.

8. I disagree with Dr. Mongan's description of the person of ordinary skill in the art. Persons of ordinary skill working on the type of image analysis or computer vision problems characteristic of the claims of the '945 patent would typically have the type of experience I described in my original declaration.

9. However, I understand that Dr. Mongan has also expressed that in his view, the definition he provided is not materially different from the definition I provided in my original declaration. *See* EX2028, ¶48. Based on this clarification from Dr. Mongan, I interpret Dr. Mongan's characterization of the level of skill in the art as intended not to materially differ from mine. Applying this further clarification from Dr. Mongan that no material change to the level of skill I described is intended, the opinions I expressed in my original declaration would remain the same under either my description of the level of skill in the art or under Dr. Mongan's.

IV. CLAIMS 1-2 AND 4-6 WERE OBVIOUS AS ILLUSTRATED BY KIM, INVISALIGN, AND SALAH

10. As I explained in my original declaration, it is my opinion that each of claims 1-2 and 4-6 was obvious in view of Kim, Invisalign, and Salah. In this

section, I address certain particular arguments raised by Drs. Mongan and Kusnoto regarding this combination.

A. A POSA Would Have Had Reason to Use the Image Processing Techniques Taught by Salah to Detect Distances Between Tooth Edges and Corresponding Aligner Edges for Each of a Plurality of Teeth with a Reasonable Expectation of Success

11. In my original declaration, I described how the remote orthodontic treatment teachings of Kim (EX1005) would be enhanced by applying Invisalign's teaching to assess whether or not an aligner was seated poorly based on a comparison with a threshold (1 mm), which Invisalign illustrates with an example image of an aligner worn on a patient's teeth, and which Invisalign characterizes as "Aligner seating poorly, >1 mm." EX1006, 1; EX1002, ¶58. I also illustrated a simple example of applying a "simple Canny edge detection technique" (a basic edge detection technique disclosed by Salah) which was able to detect the edges of teeth and aligners (between which such distances would be measured), despite being less advanced than techniques taught in Salah, which would "go beyond mere detection of edges, and also provide specific identification of the objects found in different regions defined by the detected edges." EX1002, ¶82-83.

12. Dr. Mongan suggests that the image selected by Invisalign to represent a poor aligner fit was "not representative of the typical aligner fit observed by dental practitioners at the time." EX2028, ¶¶141; *see id.*, ¶87. Dr. Mongan refers to Dr. Kusnoto as the basis for this opinion. *See id.* Dr. Kusnoto

asserts that different images (which he says “post-date the ’248 patent”) would have been more “representative of what an orthodontist would have observed in” 2017. EX2030, ¶¶61-63. For example, in a photo that Dr. Kusnoto claims to be more representative, he asserts that “separation cannot be assessed with precision.” EX2030, ¶63 (citing EX2063, 1); *see also id.*, ¶62 (asserting other images have “small separation [that] is difficult to detect”). Dr. Kusnoto does not describe any analysis or attempts to detect edges in any of his example images from which such separations can be assessed.

13. Dr. Kusnoto is mistaken in his assertion that the photos he describes as “more representative” could not be used to detect separations; in fact, detecting edges of teeth and aligners in the images is straightforward even with very old edge detection technology, and as I described in my original declaration, determining separation based on such edges is simple and straightforward. *See* EX1002, ¶¶82-87. By way of illustration, I have excerpted some of the images that Dr. Kusnoto asserts would have been representative of aligner fit (from EX2055, 2, and EX2063, 1) and performed edge detection on them using the same edge detection technique (Canny edge detection and bilateral filtering) I described in paragraph 83 of my original declaration, and the edges of the teeth and the aligner in these images can be resolved without difficulty. I have reproduced the results from this edge-detection process below, along with annotations pointing out the

edges of teeth and aligners for some teeth of the depicted dental arches. Below are reproductions of two images taken from EX2055 (labeled as “excellent tracking” and “problem tracking”), as well as the image from EX2063, with each image followed by the results of the above-described edge detection process.

Fig. A: “Excellent Tracking” (EX2055, 2)

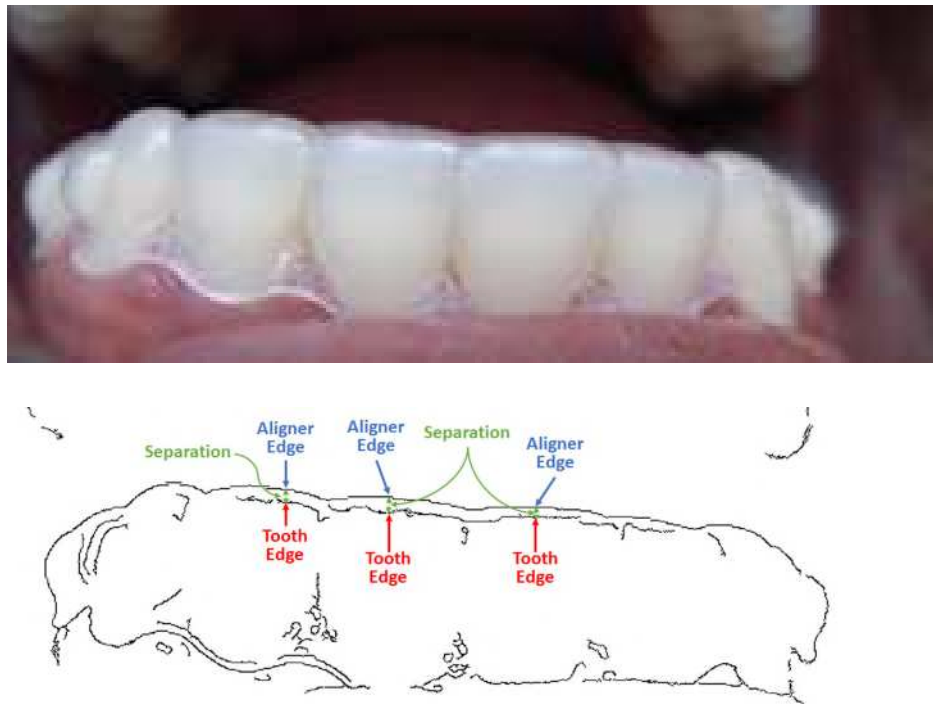


Fig. B: “Problem Tracking” (EX2055, 2)

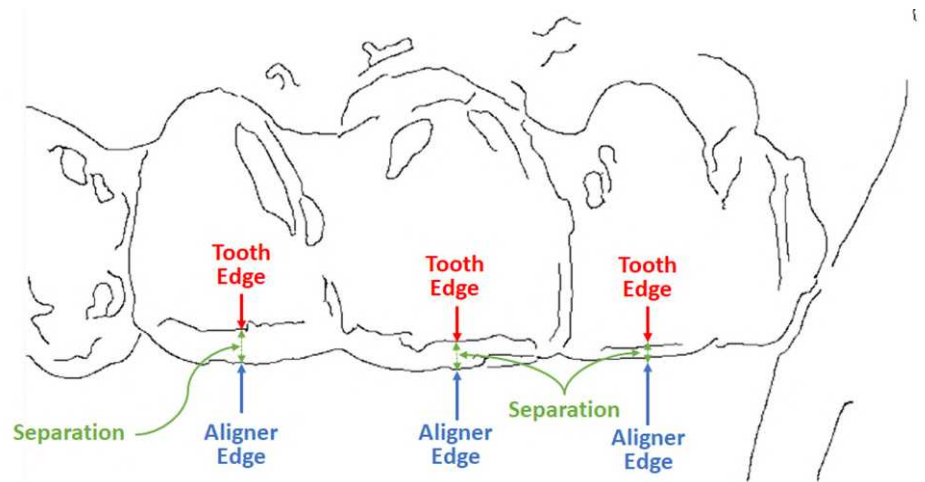
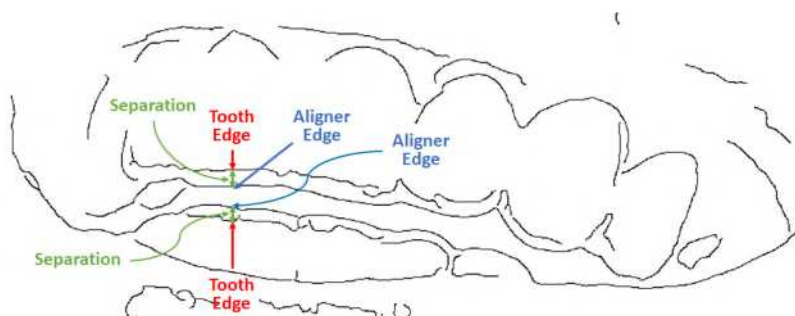


Fig. C: “Clear aligner therapy” (EX2063, 1)



14. As can be plainly seen above, the edges of teeth and aligners, and the gap between them, can be resolved even with simple edge detection techniques. This is true not only for the problem tracking image (Fig. B) and the image from the “Clear aligner therapy” reference (Fig. C), but also for the image labeled as excellent tracking (Fig. A), even though the gap between the teeth and the aligner is smaller in that image. Applying more advanced techniques, such as the remaining well-known image processing techniques taught by Salah, would have been expected to resolve the locations of each tooth’s edge and the corresponding aligner edges with even greater precision and accuracy, allowing the detection, identification, and measurement of separations between each tooth and the

corresponding edges of the aligner in a straightforward and predictable manner.

Thus, contrary to Dr. Kusnoto's assertion, separation can be assessed in the images he asserts are representative, even using techniques less advanced than those taught by Salah.

15. Dr. Mongan also asserts that a POSA would have been deterred from using contour detection to detect edges of teeth and aligners in images of patients wearing aligners because he claims that "Salah teaches that high contrast is required to achieve a quality analysis." EX2028, ¶122. For this reason, Dr. Mongan asserts that a "POSA would have understood Salah to teach away from using contour detection with aligner images as the methodology would need to be altered to detect areas of low contrast instead." *Id.*

16. Dr. Mongan is mistaken. I understand that (as Dr. Mongan acknowledges) expression of a preference for one alternative is not a teaching away; rather, to teach away a reference must "criticize, discredit, or otherwise discourage investigation into the claimed invention." EX2028, ¶42. Salah does not teach that only maximal-contrast areas can produce useful contours. Although Salah mentions that a "blurred zone" may produce lower-quality contours (EX1008, 60:20-22), Dr. Mongan does not suggest that images of aligners on teeth would be blurred. The image from Invisalign that I analyzed in my original declaration as well as the images that Dr. Kusnoto suggests to be representative

have clearly-discernable tooth and aligner edges, with no issues of blur or low contrast that would have discouraged a POSA.

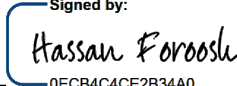
17. Indeed, Salah teaches that a range of contrast levels may be used, noting that a threshold may be chosen to trade off between greater numbers of lower-contrast contours and smaller numbers of higher-contrast contours. A POSA would have understood how to apply the image processing techniques taught by Salah to obtain quality contours of images of teeth with aligners worn in a service position. Indeed, the analysis I performed in this declaration and my original declaration shows that even with simple techniques, the relevant edges are discernable. The more advanced and varied image processing techniques taught by Salah would make detection of such edges even more straightforward.

V. CONCLUDING STATEMENTS

18. In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

19. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: October 4, 2024

By:  Signed by:
Hassan Foroosh
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Hassan Foroosh, Ph.D.

VI. APPENDIX – CITED PETITIONER EXHIBITS

Exhibit No.	Description
1001	U.S. Patent No. 11,109,945 to Salah et al.
1002	Declaration of Hassan Foroosh, Ph.D.
1003	Curriculum Vitae of Hassan Foroosh, Ph.D.
1005	U.S. Patent Pub. No. 2017/0281313 to Taewon Kim (“Kim”)
1006	Align Technology, Invisalign Clinical Monitoring Guide (2003) (archived September 26, 2003, at http://web.archive.org/web/20030926024959/http://www.invisaligncec.com:80/consistent/pdfs/ICMG_Final.pdf) (“Invisalign”)
1008	Translation of PCT Pub. No. WO 2016066651 to Salah et al.

VII. APPENDIX – CITED PATENT OWNER EXHIBITS

Exhibit No.	Description
2028	Declaration of Dr. John Mongan in Support of Patent Owner's Response
2030	Declaration of Dr. Budi Kusnoto in Support of Patent Owner's Response
2055	Making Sure Your Invisalign Aligners Fit Correctly, Morita Orthodontics
2063	N. Smith, Clear aligner therapy: An esthetic approach to total patient care, Dentistry IQ