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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

3SHAPE A/S and 3SHAPE INC.
Petitioners

v.

DENTAL IMAGING TECHNOLOGIES CORPORATION
Patent Owner

Case No. IPR2024-00549
Patent 11,234,798

**PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO.
11,234,798 B2 UNDER 35 U.S.C. §§311–19 and 37 C.F.R. §42.100 *et seq.***

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I. INTRODUCTION

3SHAPE A/S and 3SHAPE INC. (“Petitioners”) respectfully request *inter partes* review for Claims 1–20 of U.S. Patent No. 11,234,798 (“’798 Patent”) (EX1001) in accordance with 35 U.S.C. §§311–19 and 37 C.F.R. §42.100 *et seq.*

II. MANDATORY NOTICES PURSUANT TO 37 C.F.R. §42.8(a)(1)

A. Real Parties-In-Interest

Pursuant to 37 C.F.R. §42.8(b)(1), Petitioners certify that 3Shape A/S, 3Shape Inc., 3Shape Holding A/S, 3Shape Trios A/S, and 3Shape Poland sp. z.o.o. are real parties-in-interest. Out of an abundance of caution, 3Shape Germany GmbH, 3Shape France SAS, 3Shape Italy SRL, 3SHAPE UK LIMITED, 3SHAPE DOOEL Skopje, 3Shape S.A.S., 3Shape (Shanghai) Co., Ltd., 3Shape Do Brasil Soluções Tecnológicas Para Saude Ltda, 3Shape Australia Pty Ltd., 3Shape Trios Sociedad Limitada, 3Shape Japan GK, 3Shape Ukraine Ltd., SC Investment Company, LLC, SoundBite Technology, LLC, Shenzhen Full Contour Design Company Ltd., 3Shape Design Services Costa Rica, S.R.L., 3Shape Design Services, LLC, 3Shape Medical Equipment Manufacture (Shanghai) Ltd., 3Shape Korea Ltd., 3Shape Manufacturing US LLC, EQT IX JAWS BIDCO S.A.R.L., Clausen Engineering APS, Tais Clausen, DM Family Office ApS, Deichmann Media APS, and Nikolaj Hoffmann Deichmann are also identified as real parties-in-interest, for purposes of compliance with 35 U.S.C. §312(a)(2).

B. Identification of Related Matters Under 37 C.F.R. §42.8(b)(2)

The following is a list of any judicial or administrative matters that would affect, or be affected by, a decision in this proceeding:

Related District Court Proceeding

3Shape A/S v. Carestream Dental, LLC et al., Civ. Action No. 1:22-cv-01829 (N.D. Ga.) (“Related Litigation”).

Related Applications

U.S. Patent Application No. 16/160,230, filed on October 15, 2018 (U.S. Patent No. 11,234,798) is a continuation of U.S. Patent Application No. 14/209,648, filed on March 13, 2014 (U.S. Patent No. 10,098,713), and claims priority to U.S. Provisional Application No. 61/784,535, filed on March 14, 2013.

U.S. Patent Application No. 17/581,664, filed on January 21, 2022 (pending) is a continuation of U.S. Patent Application No. 16/160,230.

C. Lead and Backup Counsel

Pursuant to 37 C.F.R. §§42.8(b)(3) and 42.10(a), Petitioners hereby identify its lead and backup counsel as follows:

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Powers of Attorney are being filed concurrently herewith in accordance with
37 C.F.R. §42.10(b).

D. Service Information Under 37 C.F.R. §42.8(b)(4)

Petitioners consent to e-mail service at the addresses listed above.

III. PAYMENT OF FEES

The undersigned authorizes the Office to charge Deposit Account No. 02-4800 for fees required by 37 C.F.R. §42.15(a).

IV. REQUIREMENTS UNDER 37 C.F.R. §42.104

A. Grounds for Standing

Pursuant to 37 C.F.R. §42.104(a), Petitioners certify that the '798 Patent is available for *inter partes* review in accordance with 37 C.F.R. §42.102(a)(2). Petitioners are not barred/estopped from requesting *inter partes* review challenging the claims of this patent on the grounds herein.

This Petition is filed within one year from when Petitioners were served counterclaims by Patent Owner in the Related Litigation, which asserted infringement of this patent. *See* EX1013.

Neither Petitioners nor its privies received a Final Written Decision under 35 U.S.C. §318(a) regarding any claim of this patent on any ground that was raised or could have been raised by them in any *inter partes* review, post grant review, or covered business method patent review.

B. Identification of Challenges and Precise Relief Requested

Pursuant to 37 C.F.R. §42.104(b), Petitioners challenge Claims 1–20 of the '798 Patent, requesting that these claims be found unpatentable over the prior art for the below reasons.

Ground	References	Basis	Claims Challenged
1	Zhang, <i>et al.</i> , PCT Publication WO 2010/077380A2 (“Zhang”) (EX1007) in view of Babayoff, U.S. Patent 7,698,068B2 (“Babayoff”) (EX1008)	35 U.S.C. §103	1–6, 10–15, 17–19
2	Zhang in view of Babayoff and Fisker, <i>et al.</i> , PCT Publication WO 2013/010910A1 (“Fisker”) (EX1009)	35 U.S.C. §103	7, 16
3	Zhang in view of Babayoff and Dillon, <i>et al.</i> , U.S. Patent Publication 2012/0062701A1 (“Dillon”) (EX1010)	35 U.S.C. §103	8
4	Zhang in view of Babayoff and Johnson, “Spin-Images: A Representation for 3-D Surface Matching,” 1997 (EX1011)	35 U.S.C. §103	9, 20

Petitioners also rely upon evidence listed in the Exhibit List, including the Declarations and *Curriculum Vitae* of Dr. Eli Saber (EXs.1003, 1004) and Dr. Sylvia Hall-Ellis (EXs.1005, 1006).

C. Prior Art Qualification of Asserted References

The ’798 Patent was filed on October 15, 2018 as U.S. Patent Application No. 16/160,230 (“’230 Application”). EX1002. For purposes of this Petition, Petitioners

assume that earliest effective filing date is March 14, 2013—the filing date of priority U.S. Provisional Application No. 61/784,535.¹

Even if the '798 Patent is deemed entitled to its earliest priority date, all the applied references in this Petition are prior art.

Zhang (EX1007) (2010), Babayoff (EX1008) (2010), and Johnson (EX1011) (1997) constitute prior art at least under §102(b).

Fisker (EX1009), published in English on January 24, 2013, is based on a PCT application filed in English on July 12, 2012 that identified the US as a designated state, constitutes prior art at least under §102(e).

Dillon (EX1010), published on March 15, 2012 and based on a US application filed on August 25, 2011, constitutes prior art at least under §102(e). The '798 Patent includes two inventors (Craig Andreiko and Neil Judell) who were not named as inventors in Dillon.

V. BACKGROUND

A. The Purported Invention

The '798 Patent describes a computer system that generates multiple images obtained from various scans of a patient's mouth to create a three-dimensional

¹ Petitioners do not concede that any challenged claim is entitled to an effective filing date of March 14, 2013.

representation of the mouth. In particular, it describes how multiple images from the various scans are stitched together and extraneous soft-tissue elements (such as the tongue, cheeks, and lips) are removed from the images to form a more complete 3D model of the occlusal surface of the patient's teeth. EX1003, ¶34.

The purported novelty is not 3D imaging of teeth from scans (which had been done many others for years before), but, rather, the removal of the soft tissue components from the ultimate 3D representation. But this, too, has been done before. EX1003, ¶35.

B. The '798 Patent Examination History

The '798 Patent issued from U.S. Application No. 16/160,230, filed on October 15, 2018, and claims priority to the earlier U.S. Application No. 14/209,648, filed on March 13, 2014 (now U.S. Patent No. 10,098,713), and U.S. Provisional Application No. 61/784,535, filed on March 14, 2013. EX1002. The patent then issued on February 1, 2022. EX1001.

C. Person of Ordinary Skill in the Art ("POSITA")

A POSITA is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity. Regarding this patent, a POSITA would have at least (1) a bachelor's degree in electrical engineering, computer engineering, or computer science (or equivalent course work) and two to three years of work experience in 3D imaging and modeling of physical

structures, or (2) a master's degree in electrical engineering, computer engineering, or computer science (or equivalent course work) with a focus in 3D imaging and modeling of physical structures. EX1003, ¶33.

VI. CLAIM CONSTRUCTION

The Board only construes the claims when necessary to resolve the underlying controversy. *Toyota Motor Corp. v. Cellport Systems, Inc.*, IPR2015-00633, Paper 11 at 16 (PTAB Aug. 14, 2015). Other than the terms addressed below, Petitioners believe that no express constructions of the claims are necessary.

Petitioners note that the constructions of some claim terms are disputed in the Related Litigation. Petitioner asserted that the terms “image data” (Claims 1, 9, 10, 18–20), “image frames” (Claims 1, 3, 10, 14), and the entirety of element [1.6] are indefinite, while the Patent Owner asserted that these terms should be given their plain and ordinary meaning. EXs1015, 1014. While the proper metes and bounds of these terms are disputed, the cited prior art falls within these bounds whatever they may be. Petitioners are not waiving their right to contest indefiniteness in the Related Litigation by virtue of this Petition.

Petitioner also asserted that “occlusal surface” (Claims 1–4, 6, 8–12, 14, 15, 18, 20) means “the biting surface of a patient's teeth”; the “contiguous scan” terms (Claims 1, 3, 10, 14) mean “a scan of an/the occlusal surface made in a single, uninterrupted motion of the scanning wand”; and the “additional surface” terms

(Claims 1–3, 6, 8–11, 14, 15, 18–20) mean “a subsequent additional scan of a surface (e.g. labial, lingual surface) to the contiguous scan of the occlusal surface.” EX1014. Patent Owner asserted that they all should be given their plain and ordinary meaning. EX1015.

Petitioners believe that resolution of this Petition does not depend on which constructions are used because these features of the claims are disclosed by the prior art regardless of the construction. Petitioner contends that these terms should be interpreted consistent with the *Philips* standard. In any event, the Board has consistently held that Petitioners may assert indefiniteness positions in parallel litigation, while simultaneously arguing that the prior art discloses the elements containing those terms. *See Target Corp. v. Proxicom Wireless, Inc.*, IPR2020-00979, Paper 11 at 16–17 (PTAB Dec. 4, 2020); *Sony Interactive Entertainment LLC v. Bot M8, LLC*, IPR2020-00963, Paper 9 at 11 (PTAB Nov. 20, 2020). *See also Intel Corp. v. Qualcomm Inc.*, 21 F.4th 801, 812–14 (Fed. Cir. 2021). The Challenged Claims are unpatentable under all the potential constructions.

VII. PETITIONERS HAVE A REASONABLE LIKELIHOOD OF PREVAILING

Claims 1–20 of the '798 Patent are unpatentable over the following prior art asserted in Grounds 1–4. EX1003, ¶¶53, 245, 268, 296, 319.

A. Claims 1–6, 10–15, and 17–19 Would Have Been Obvious Over Zhang in View of Babayoff (Ground 1).

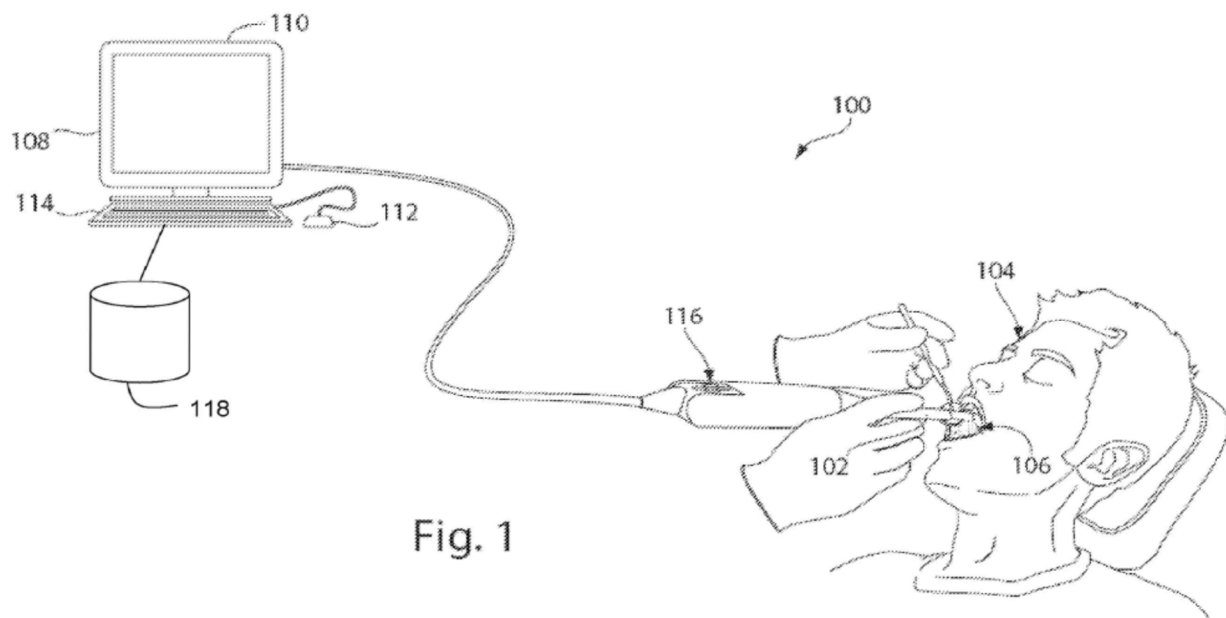
The elements of Claims 1–6, 10–15, and 17–19 can be found in the prior art of Zhang and Babayoff. EX1003, ¶¶37–40, 53.

1. Claim 1 (Preamble): A system for generating an intra-oral scan of dentition, the system comprising:

“[D]entition refers to the arrangement of teeth [i]n the oral cavity of a patient.”

EX1001, 12:3–4; EX1003, ¶56.

Zhang describes a scanning system 100 for creating a 3D reconstruction of dental objects. EX1007, ¶[0041], Fig. 1. “[T]he system 100 may include a scanner 102 that captures images from a surface 106 of an object 104, such as a dental patient, and forwards the images to a computer 108, which may include a display 110....” *Id.*; EX1003, ¶57.



“Dental objects” include intraoral structures, such as dentition. EX1007, ¶[0038] (“The term ‘dental object’, as used herein, is intended to refer broadly to subject matter related to dentistry. This may include intraoral structures such as dentition, and...individual teeth, quadrants, full arches, pairs of arches..., soft tissue, and the like....”); EX1003, ¶58.

Babayoff also discloses an intra-oral scanning system for both hard tissue (teeth, or dentition) and soft tissue (gums, cheeks, and tongue). EX1008, 4:37–39, 6:32–47, 7:53–8:22, 28:8–24; EX1003, ¶59.

If the preamble is limiting, both Zhang and Babayoff disclose a system for generating scans of dentition. EX1003, ¶60.

a. [1.1]: a memory; and

Zhang discloses that the system includes memory. EX1007, ¶[0050] (“The system 100 may include a computer-usable or computer-readable medium. The computer-usable medium 118 may include one or more memory chips (or other chips, such as a processor, that include memory)...”), ¶[0046]; EX1003, ¶62.

Similarly, Babayoff discloses that the system includes memory. EX1008, 6:42 (“a memory utility for storing the data”), 28:20; EX1003, ¶63.

Zhang and Babayoff both disclose that the system has memory. EX1003, ¶64.

b. [1.2]: a processor coupled to the memory, wherein the processor is configured to:

Zhang discloses that the computer in the system includes a processor coupled to memory. EX1007, ¶[0046] (“In one embodiment, the computer 108 includes a personal computer with a dual 2.8 GHz Opteron central processing unit, 2 gigabytes of random access memory...”), ¶[0100]; EX1003, ¶66.

Babayoff also discloses a processor coupled to the memory for manipulating the information stored therein. EX1008, 6:43–46 (“a processor utility for manipulating said first data set to provide desired data therefrom...”), 28:21–23; EX1003, ¶67.

Zhang and Babayoff both disclose that the system has a processor coupled to memory. EX1003, ¶68.

c. [1.3]: generate a contiguous scan of an occlusal surface of at least a part of one arch of dentition,

This element requires the creation of a contiguous scan of an occlusal surface that includes at least part of one arch. EX1003, ¶70.

Zhang discloses that system 100 is capable of creating a contiguous scan of dental objects (which includes occlusal surfaces and arches), which meets the requirements of this element. It also specifically notes that the information obtained from scanner 102 is sent to computer 108, which contains a processor that analyzes

and processes the information, to create the scan. EX1007, ¶¶[0041], [0046]; EX1003, ¶71.

Zhang discloses how scanner 102 can take contiguous scans through a continuous/uninterrupted data acquisition process. EX1007, ¶[0043] (“The scanner 102 may, through such a continuous data acquisition process, capture a point cloud of surface data having sufficient spatial resolution and accuracy to prepare dental objects such as prosthetics, hardware, appliances, and the like therefrom, either directly or through a variety of intermediate processing steps.”); EX1003, ¶72.

Zhang further discloses that these scans can be of an occlusal surface. EX1007, ¶[0098] (“intra-oral scanning often employs a number of adjacent, relatively straight global paths such as for lingual, occlusal, and buccal surfaces”), ¶[0090] (“For example, where a scan path covers a buccal surface followed by an occlusal or lingual surface, many spatial links might be identified between non-contiguous [sic] camera path segments associated with each surface.”); EX1003, ¶73.

Zhang also discloses that the scan can include dentition such as arches. EX1007, ¶[0045] (“A scan may capture a three-dimensional representation of some or all of the dentition according to particular purpose of the scan. Thus, the scan may capture a digital model of a tooth, a quadrant of teeth, or a full collection of teeth including two opposing arches, as well as soft tissue or any other relevant intraoral structures.”); EX1003, ¶74.

Zhang discloses that the processor generates a contiguous scan of the occlusal surface that includes arches. EX1003, ¶75.

- d. **[1.4]: remove image data of soft tissue from the contiguous scan of the occlusal surface based at least in part on an analysis of 3D data from the contiguous scan to distinguish between image data of the dentition and the image data of the soft tissue, wherein the soft tissue includes at least one selected from a group consisting of a tongue, a cheek, and a lip, and**

This element has multiple parts: (1) 3D image data from the contiguous scan of the occlusal surface includes image data of both soft tissue and dentition; (2) the soft tissue is the tongue, cheek, or lip; (3) the 3D image data is analyzed to distinguish between soft tissue and dentition, and (4) the soft tissue image data is then removed from the contiguous scan of the occlusal surface based on this analysis. The occlusal surface of a tooth is at the top of the tooth (the biting surface). EX1003, ¶77.

Zhang discloses that the contiguous scan data can include soft tissue and dentition (EX1007, ¶[0045] (“the scan may capture a digital model of a tooth, a quadrant of teeth, or a full collection of teeth including two opposing arches, as well as soft tissue”) and that the scan data can create a 3D model of the dental object, which includes soft tissue (*id.*, ¶[0014] (“The three-dimensional model of the dental object may include one or more of gums and soft tissue”)). EX1003, ¶78.

Babayoff also discloses scans of soft tissue and dentition to obtain 3D data:

There are also procedures in which particularly good three-dimensional definition of a large area of the intraoral cavity is required, and it may be necessary at times to scan parts of the cavity sequentially and then “stitch” the various data sets together....the data sets often include surface data relating to the soft tissues such as gums, cheeks and tongue, for example....

EX1008, 2:1–18; EX1003, ¶79.

Babayoff further discloses that soft tissue image data may be separated or removed from the hard tissue² data, using color information from the images, for example. EX1008, 5:11–16 (“By eliminating the data associated with the soft tissues, and proceeding with stitching only the hard tissues using the color data, the quality of the stitching procedure is significantly better than when using the full intra-oral data for the stitching procedure”); 23:34–36 (“separation of the hard tissue from the soft tissue results in a smaller database that needs to be analysed to identify the finish line”); 24:36–40 (“The data in these entities not corresponding to the hard tissues may de [sic] discarded or simply noted and set aside for future reference, thereby providing modified entities (IS'₁, IS'₂,...IS'_n) comprising the data of interest

² Babayoff defines hard tissue to include the teeth (dentition). EX1008, 21:6–7; EX1003, ¶80, n.1.

relating to the hard tissues, for example”); 26:4–7 (“The method according to this embodiment may be modified to separate the soft tissues from the hard tissues, once the demarcation line between the two tissues is known, as determined above”). Babayoff describes how this removal process may be accomplished using color data. *Id.*, 22:11–61, 24:25–47; EX1003, ¶80.

Babayoff notes how the processor is part of the system that processes the image data. EX1008, 8:30–66, 9:63–10:28; EX1003, ¶81.

Zhang in combination with Babayoff discloses all the requirements of Element [1.4]—a contiguous scan of the occlusal surface that includes 3D image data of both soft tissue and dentition, where the soft tissue can include the tongue or cheek, and where image data is analyzed to distinguish between the soft tissue and dentition (hard tissue) so that the soft tissue image data can be removed. EX1003, ¶82.

e. [1.5]: associate a scan of at least one additional surface to the contiguous scan of the occlusal surface by

The term “additional surface” refers to a surface of the teeth that is not the occlusal surface, such as labial and lingual surfaces. EX1001, 8:2–4 (“the at least one additional surface comprises a plurality of labial surfaces and lingual surfaces”); EX1003, ¶84. Labial refers to the surface of the teeth in the front of the mouth facing the lips, while lingual refers to the surface of the tooth facing the tongue. Buccal is

similar to labial but refers to the surface of the tooth further back in the mouth facing the cheeks. From context, it is clear that the labial surface includes the buccal surface.³ EX1003, ¶85.

This element, therefore, requires associating scans of a lingual or labial surface with the scan of the occlusal surface. *Id.*, ¶86.

Zhang discloses that subsequent scans of various surfaces (additional data sets) are connected (or associated) with one another to form more complete 3D information about the teeth. EX1007, ¶[0094] (“After path optimization is complete, additional three-dimensional data may be added based upon the one or more additional data sets and the one or more additional poses from between key frames”); EX1003, ¶87.

The subsequent scans (additional data sets) can include one of the occlusal surface and others of the buccal/labial and lingual surfaces or from additional data

³ For instance, Figures 2&3 of the '798 Patent reference the labial scan as being of all the teeth surfaces facing away from the tongue, and not just those near the lips. Nothing in the patent suggests that the buccal surfaces are somehow excluded from scans or the ultimate 3D reconstruction, which consists of all teeth. EX1003, ¶85, n.2.

sets. EX1007, ¶[0098] (“intra-oral scanning often employs a number of adjacent, relatively straight global paths such as for lingual, occlusal, and buccal surfaces”). These additional data sets can then be related to one another (i.e., associated) to form a 3D representation. *Id.*, ¶[0095] (“Thus for example two data sets from buccal and lingual scan segment may be related to one another based upon camera position, the three-dimensional data recovered from the respective data sets, or any other data acquired during a scanning process.”). EX1003, ¶88.

Zhang discloses that scans of additional surfaces are associated with the contiguous scan of the occlusal surface. *Id.*, ¶89.

f. [1.6]: analyzing the scan data to identify a portion of the scan of the at least one additional surface that overlaps with a portion of the contiguous scan of the occlusal surface,

This element requires analyzing scan data to identify overlaps between the additional surfaces (lingual and labial) and the occlusal surface. EX1003, ¶91.

Zhang describes how his system analyzes the scan data to link images from different parts of the mouth by finding overlaps in images. EX1007, ¶[0015] (“Identifying at least one non-sequential spatial link may include identifying the at least one non-sequential spatial link based upon an overlap in three-dimensional data reconstructed from the data set for each of the two nonsequential ones of the poses”), ¶[0065] (“Key frames may also or instead be selected based upon an amount of

image overlap from the preceding key frame and/or a candidate for a following key frame (if available)"); EX1003, ¶92.

Zhang further notes that the scan data can include images of the occlusal surface and lingual surface (i.e., an additional surface). EX1007, ¶[0098] (“intra-oral scanning often employs a number of adjacent, relatively straight global paths such as for lingual, occlusal, and buccal surfaces”); EX1003, ¶93.

Babayoff also discloses how multiple data sets (scans of the hard tissue, e.g., teeth) are analyzed to determine overlaps in the data so that they can be properly stitched together. EX1008, 4:50–67; EX1003, ¶94.

Zhang and Babayoff disclose that the scan data is analyzed to identify overlaps between the additional surface (lingual surface) and the occlusal surface. EX1003, ¶95.

- g. [1.7]: wherein the scan of the at least one additional surface includes a sequence of image frames including a plurality of image frames of the occlusal surface interspersed with a plurality of image frames of the at least one additional surface, and**

This element requires that the scan of the additional surface be comprised of a sequence of images (the image frames) that include images of both the occlusal and additional surfaces. EX1003, ¶96.

Zhang discloses how the scans are comprised of a sequence of images (which he calls “frames”) of the surfaces. EX1007, ¶[0064] (“The process 700⁴ may begin with preprocessing as shown in step 710. It will be understood that preprocessing as described herein presupposes the availability of a number of frames of image data from which a camera path and three-dimensional model can be reconstructed.”), ¶[0065] (“key frames may be selected from among all of the frames of data acquired from the scanner along a camera path”); EX1003, ¶98.

Zhang further discloses that scan paths can obtain images of multiple types of surfaces (e.g., occlusal, lingual, and buccal) in the same scan. EX1007, ¶[0090] (“where a scan path covers a buccal surface followed by an occlusal or lingual surface, many spatial links might be identified between non-contiguous [sic] camera path segments associated with each surface”). Zhang contemplates that there will be significant overlaps between successive images in the scans, which allows them to be linked together to form a complete 3D model of the teeth. *Id.*, ¶[0065] (“In principle, these key frames should be related to one another in a manner that

⁴ By “process 700,” Zhang means the process of creating a 3D reconstruction of the teeth. EX1007, ¶[0063]. EX1003, ¶98, n.3.

permits characterization of a camera path, typically through the registration of overlapping three-dimensional data in respective key frames”). EX1003, ¶99.

Zhang discloses that the scan of an additional surface (lingual surface) includes sequences of images of both the additional and occlusal surfaces. *Id.*, ¶100.

h. [1.8]: determining a position of the scan of the at least one additional surface relative to the scan of the occlusal surface based on the identified overlapping portions,

This element requires determining the relative positions of scans of an additional surface with the scan of the occlusal surface by using overlaps in the two scans. EX1003, ¶102.

Zhang discloses how scans of different surfaces are related to one another based on 3D data from each scan. EX1007, ¶[0095] (“Thus for example two data sets from a buccal and lingual scan segment may be related to one another based upon camera position, the three-dimensional data recovered from the respective data sets”). While referring to just the buccal and lingual scans in that example, Zhang makes clear that separate scans of lingual, occlusal, and buccal surfaces are used to create the ultimate 3D reconstruction. *Id.*, ¶[0098] (“intra-oral scanning often employs a number of adjacent, relatively straight global paths such as for lingual, occlusal, and buccal surfaces”); ¶[0097] (“a three-dimensional model of the dental object may be reconstructed using known techniques based on the optimized camera path and the plurality of data sets”). EX1003, ¶103.

Zhang further describes how this relationship is based on overlaps found in key frames (portions) of the scans.

[T]hese key frames should be related to one another in a manner that permits characterization of a camera path, typically through the registration of overlapping three-dimensional data in respective key frames. Various methods are known in the art for selecting a subset of frames of data as key frames, including techniques based on image overlap, camera path distance, the number of intervening non-key frames and so forth....Key frames may also or instead be selected based upon an amount of image overlap from the preceding key frame and/or a candidate for a following key frame (if available). Too little overlap makes frame-to-frame registration difficult. Too much overlap drives larger numbers of key frames and therefore larger amounts of data to analyze. Key frames may be selected based on spatial displacement, meaning that an upper limit may be placed on the amount of overlap from one key frame to the next.

EX1007, ¶[0065]; EX1003, ¶104.

Zhang then explains that positional data is obtained from these overlapping key frames of the surfaces. EX1007, ¶[0066] (“Once key frames have been selected, additional processing may be performed. For example, full image data (e.g., full resolution center and side channel images) may be stored for each key frame, along

with image signature data, point cloud centroid calculations, and any other measured or calculated data to support use of the key frames in a three-dimensional reconstruction process as described herein.”); EX1003, ¶105.

Zhang discloses that the position of the scans of the additional surface and the occlusal surface is determined through the overlapping portions of that data. EX1003, ¶106.

- i. **[1.9]: wherein the processor is configured to generate the contiguous scan of the occlusal surface by capturing a plurality of partially overlapping image frames of the occlusal surface and stitching the overlapping image frames together to form a 3D model of the occlusal surface,**

This element requires that the processor generates a contiguous scan of the occlusal surface by capturing a sequence of overlapping images of the occlusal surface and stitching them together to form a 3D model of the occlusal surface. EX1003, ¶108.

Zhang discloses how scanner 102 and computer 108 (which includes the processor) are coupled together and that the system captures the images obtained from the scanner. EX1007, ¶[0047] (“Communications between the computer 108 and the scanner 102 may use any suitable communications link”), ¶[0046] (“the system can be operated to capture more than five thousand point per image set in real time”); EX1003, ¶109.

The system captures scan data in a continuous process as the scanner moves along a surface in the patient's mouth. EX1007, ¶[0043] (“the scanner may be shaped and sized for intraoral scanning and data capture, such as by insertion into a mouth of an imaging subject and passing over an intraoral surface 106 at a suitable distance to acquire surface data from teeth, gums, and so forth. The scanner 102 may, through such a continuous data acquisition process, capture a point cloud of surface data having sufficient spatial resolution and accuracy to prepare dental objects...therefrom, either directly or through a variety of intermediate processing steps.”); EX1003, ¶110.

This scan data includes images. EX1007, ¶[0048] (“In an example of general operation of a three-dimensional image capture system 100, the scanner 102 may acquire two-dimensional image sets at a video rate while the scanner 102 is passed over a surface of the subject”). And Zhang characterizes individual images as “frames.” *Id.*, ¶[0055] (“The real-time processing controller 316 may provide images or frames to the high-speed (video rate) processing pipeline 330 for reconstruction of three-dimensional surfaces from the two-dimensional source data in real time”). EX1003, ¶111.

One of the data sets acquired in Zhang is a contiguous scan (scan path) of the occlusal surface. EX1007, ¶[0090] (“where a scan path covers a buccal surface followed by an occlusal or lingual surface, many spatial links might be identified

between non-contiguous [sic] camera path segments associated with each surface”). EX1003, ¶112.

Zhang then discusses how these overlapping image frames are stitched together to form a 3D representation of the teeth. EX1007, ¶[0003] (“In one technique for three-dimensional image reconstruction, a number of images or image sets of an object are captured with a camera that travels in a path over the surface of the object. Information from this catalogue of information can then be used to reconstruct a three-dimensional model of the object....”), ¶[0048] (“The three-dimensional data for each newly acquired two-dimensional image set may be derived and fitted or ‘stitched’ to existing three-dimensional data using a number of different techniques”), ¶[0055] (“The three-dimensional point clouds from individual image sets may be combined by a three-dimensional stitching module 336. Finally, the stitched measurements may be combined into an integrated three-dimensional model by a three-dimensional model creation module 338.”), ¶[0056] (“key frames should be related to one another in a manner that permits characterization of a camera path, typically through the registration of overlapping three-dimensional data in respective key frames”); EX1003, ¶113.

Zhang discloses each of the requirements of this element. The system, through the scanner, computer, and processor, generates a contiguous scan of the occlusal

surface by capturing a series of overlapping images, which are then stitched together to form a 3D representation of the teeth. EX1003, ¶114.

- j. **[1.10]: wherein the processor is configured to remove the image data of the soft tissue from the contiguous scan by removing the image data of the soft tissue from the overlapping image frames used to generate the occlusal scan, and**

This element requires the processor to remove image data of the soft tissue from the overall scan by removing it from the overlapping images that generated the scan. EX1003, ¶116.

As discussed in §VII(A)(1)(d), Babayoff discloses a procedure that separates or removes soft tissue image data from hard tissue data. EX1008, 5:11–16 (“By eliminating the data associated with the soft tissues, and proceeding with stitching only the hard tissues using the color data, the quality of the stitching procedure is significantly better than when using the full intra-oral data for the stitching procedure”), 23:34–36 (“separation of the hard tissue from the soft tissue results in a smaller database that needs to be analysed to identify the finish line”), 24:36–40 (“The data in these entities not corresponding to the hard tissues may be [sic] discarded or simply noted and set aside for future reference, thereby providing modified entities (IS'₁, IS'₂,...IS'_n) comprising the data of interest relating to the hard tissues, for example”), 26:4–7 (“The method according to this embodiment may be modified to separate the soft tissues from the hard tissues, once the demarcation line

between the two tissues is known, as determined above”). Babayoff describes how this removal process may be accomplished using color data. *Id.*, 22:11–61, 24:25–47. EX1003, ¶117.

The processor is part of the system that processes the image data. EX1008, 8:30–66, 9:63–10:28; EX1003, ¶118.

Babayoff discloses each of the requirements of this element. It uses a processor to remove image data of soft tissues from the overall scan data of the intraoral cavity (the occlusal surface) by removing this information from the overlapping scan data used to create the overall scan data. EX1003, ¶119.

- k. [1.11]: wherein the processor is further configured to update the contiguous scan of the occlusal surface by restitching the overlapping image frames together after removing the image data of the soft tissue to form an updated 3D model of the occlusal surface.**

This element requires the processor to replace the original scan of the occlusal surface of the teeth by restitching the overlapping image frames after the image data of the soft tissue has been removed to create an updated 3D model of the occlusal surface. EX1003, ¶121.

Babayoff discloses such a system in one of its embodiments. As described more fully in Columns 23–26 of Babayoff, the system “for accurately stitching data sets of overlapping area scanned within the intra-oral cavity” (EX1008, 23:50–51) by removing the portions of the image corresponding to the soft tissue and then

restitching the remaining image data of the hard tissue (the teeth) to create a more accurate model of the intra-oral cavity. EX1003, ¶122.

The first step takes the scan data of overlapping areas in the intra-oral cavity, including its topography and color, and stitches it together to create a 3D model of the intra-oral cavity. EX1008, 23:49–24:5 (“the various entities stitched together or combined to form a global numerical entity...”); EX1003, ¶123.

The second step involves differentiating the hard tissue from the soft tissue. EX1008, 24:29–32 (“Accordingly, in a second step 1220 of the method, the hard tissues including the teeth, fillings and prostheses are differentiated from the soft tissues including the gums, cheeks, lips and tongue.”). Next, the method discards the information associated with the soft tissue. *Id.*, 24:36–40 (“The data in these entities not corresponding to the hard tissues may de [sic] discarded or simply noted and set aside for future reference.”). EX1003, ¶124.

Finally, the third step involves taking the remaining data (without the soft tissue) and stitching it again (i.e., restitching) to form a model of the hard tissue (e.g., the occlusal surface). EX1008, 24:41–47 (“In the next step 1230 of the method, the modified entities ($IS'_1, IS'_2, \dots IS'_n$) are then manipulated in a similar manner in which the original entities ($I_1, I_2, \dots I_n$) are manipulated in the prior art, *mutatis mutandis*, to register and then stitch the various modified entities ($IS'_1, IS'_2, \dots IS'_n$) together to

provide a composite entity I' that comprises the data points corresponding at least to the hard tissues.”). EX1003, ¶125.

Babayoff discloses the requirements of this element. It updates the scan of the occlusal surface (the hard tissue) by restitching the overlapping image data of the occlusal surface after removing the image data of the soft tissue. *Id.*, ¶126.

- 2. Claim 2: The system of claim 1, wherein the processor is further configured to associate a plurality of scans of additional surfaces to the contiguous scan of the occlusal surface, wherein the plurality of scans of the additional surfaces includes a plurality of scans of labial surfaces and a plurality of scans of lingual surfaces.**

This dependent claim further refines Element [1.5] by requiring that the processor associate multiple scans of both the labial and lingual surfaces with the contiguous scan of the occlusal surface, instead of just one scan of those surfaces. EX1003, ¶128.

As stated in §VII(A)(1)(e), Zhang discloses that a plurality (“one or more”) scans of various surfaces (“additional data sets”) are associated with one another to form more complete 3D information about the patient’s teeth. EX1007, ¶[0094] (“After path optimization is complete, additional three-dimensional data may be added based upon the one or more additional data sets and the one or more additional poses from between key frames”); EX1003, ¶129.

The plurality of scans (additional data sets) can include the occlusal, buccal/labial, and lingual surfaces. EX1007, ¶[0098] (“intra-oral scanning often

employs a number of adjacent, relatively straight global paths such as for lingual, occlusal, and buccal surfaces”). These additional data sets are associated with one another to form a 3D representation. *Id.*, ¶[0095] (“Thus for example two data sets from buccal and lingual scan segment may be related to one another based upon camera position, the three-dimensional data recovered from the respective data sets, or any other data acquired during a scanning process”). EX1003, ¶130.

Zhang discloses that multiple scans of the labial and lingual surfaces are associated with the contiguous scan of the occlusal surface. *Id.*, ¶131.

3. Claim 3: The system of claim 1,

- a. [3.1]: wherein the plurality of image frames of the occlusal surface from the scan of the at least one additional surface each overlap with the contiguous scan of the occlusal surface,**

As discussed in §VII(A)(1)(g), Zhang discloses how the scans are comprised of a sequence of images (which he calls “frames”) of the surfaces. EX1007, ¶[0064] (“It will be understood that preprocessing as described herein presupposes the availability of a number of frames of image data from which a camera path and three-dimensional model can be reconstructed.”), ¶[0065] (“key frames may be selected from among all of the frames of data acquired from the scanner along a camera path.”); EX1003, ¶133.

Zhang further discloses that scan paths can obtain images of multiple types of surfaces (e.g., occlusal, lingual, and buccal) in the same scan. EX1007, ¶[0090]

(“where a scan path covers a buccal surface followed by an occlusal or lingual surface, many spatial links might be identified between non-contiguous [sic] camera path segments associated with each surface”). And Zhang contemplates that there will be significant overlaps between successive images in the scans, which allows them to be linked together to form a complete 3D model of the teeth. *Id.*, ¶[0065] (“In principle, these key frames should be related to one another in a manner that permits characterization of a camera path, typically through the registration of overlapping three-dimensional data in respective key frames”). EX1003, ¶134.

Zhang discloses that image frames from a scan of an additional surface can include image frames of the occlusal surfaces and that these image frames can overlap with images from the contiguous scan of the occlusal surface. *Id.*, ¶135.

b. [3.2]: wherein the plurality of images frames of the at least on[e] additional surface includes image frames of a labial or lingual surface, and

As stated in §VII(A)(1)(g), the scans of the additional surfaces in Zhang include multiple images frames of the lingual and buccal/labial surfaces, which satisfies this element. EX1007, ¶¶[0064], [0065], [0090]; EX1003, ¶137.

- c. **[3.3]: wherein the processor is configured to use the plurality of image frames of the occlusal surface that is included in the scan of the at least one additional surface to determine a position of the image frames of the labial or lingual surface relative to the contiguous scan of the occlusal surface.**

Zhang discloses the system uses multiple image frames of the scans of the occlusal, lingual, and labial/buccal surfaces to determine the position of the images relative to one another and the scan of the occlusal surface. EX1003, ¶139.

Zhang describes how “spatial link data,” which “reflects the physical camera path in the order in which data was acquired...characterize[s] the camera path during a data acquisition process.” EX1007, ¶[0094]. This spatial link data may be a “sequence of poses...made up of key frames (or sequential pairs of key frames)” from “additional data sets” (e.g., the occlusal, labial/buccal/and lingual surfaces). *Id.* EX1003, ¶140.

These spatial links can then be related to one another based on information from the scans. “Thus for example two data sets from a buccal and lingual scan segment may be related to one another based upon camera position, the three-dimensional data recovered from the respective data sets, or any other data acquired during a scanning process.” EX1007, ¶[0094]; EX1003, ¶141.

While Zhang provides a specific example that relates the buccal and lingual scans, the methodology applies to linking any of the surfaces together (e.g., occlusal with labial or lingual). EX1007, ¶[0097] (“a three-dimensional model of the dental

object may be reconstructed using known techniques based upon the optimized camera path and the plurality of data sets”); EX1003, ¶142.

Zhang discloses this element. EX1003, ¶143.

4. **Claim 4: The system of claim 2, wherein the occlusal surface is imaged prior to the plurality of labial and lingual surfaces, and wherein the processor is further configured to display in real-time a three-dimensional representation of the dentition as the plurality of labial and lingual surfaces are imaged.**

This dependent claim requires that the occlusal surface is imaged before the labial and lingual surfaces and further that a 3D representation of the patient’s dentition is displayed in real time as the labial and lingual surfaces are imaged. EX1003, ¶145.

Zhang allows the user to scan any surfaces in the intraoral cavity. EX1007, ¶[0045] (“A scan may capture a three-dimensional representation of some or all of the dentition according to particular purpose of the scan”), ¶58. The choice of imaging the occlusal surface first from the three types of available surfaces (occlusal, labial, and lingual) would be an obvious choice. EX1003, ¶146.

Zhang describes how his device provides 3D data in real-time. EX1007, ¶[0054] (“the high-speed processing pipeline 330 aims to provide three-dimensional data in real time, such as at a video frame rate used by an associated display”), ¶[0055] (“The real-time processing controller 316 may provide images or frames to the high-speed (video rate) processing pipeline 330 for reconstruction of three-

dimensional surfaces from the two-dimensional source data in real time”); EX1003, ¶147.

Zhang discloses the elements of this claim. EX1003, ¶148.

5. Claim 5: The system of claim 4,

- a. [5.1]: wherein the processor is configured to display in real-time the three-dimensional representation of the dentition by performing a coarse matching by matching features as the plurality of labial and lingual surfaces are imaged, and**

The element requires that the processor display a real-time coarse 3D representation of the teeth by roughly matching features from the multiple labial and lingual imaged surfaces. EX1003, ¶150.

Zhang discloses that the real-time processing controller creates a coarse, high-speed 3D representation of the teeth based on images of the various surfaces in real time (as contrasted with full resolution, *high-accuracy* 3D representations created in another part of the system). EX1007, ¶¶[0054]–[0055]. The images include images of the labial and buccal/lingual surfaces. *Id.*, ¶[0098]. EX1003, ¶151.

The 3D representation is based on 3D point cloud information created from stitching together information based on multiple images of the tooth surfaces to create a 3D model of the teeth. EX1007, ¶¶[0035], [0048], [0055]; EX1003, ¶152.

The system then displays this 3D representation on display 110. EX1007, ¶¶[0049], [0054]–[0055]; EX1003, ¶153.

Zhang discloses these limitations. EX1003, ¶154.

- b. [5.2]: wherein the processor is further configured to generate a three-dimensional reconstruction of the dentition based on a point cloud alignment after the plurality of labial and lingual surfaces are all imaged.**

Zhang further discloses that the high-accuracy processing controller creates a higher-resolution 3D model of the teeth using point cloud information obtained after the surfaces are imaged, which satisfies this element. EX1007, ¶[0056]; EX1003, ¶¶156–57.

- 6. Claim 6: The system of claim 1, wherein the processor is further configured to generate an occlusal backbone by matching selected frames of the contiguous scan of the occlusal surface that have an overlap based on an analysis of data.**

This dependent claim further requires that the processor generate an occlusal backbone by matching certain overlapping frames from the contiguous scan of the occlusal surface from an analysis of data. EX1003, ¶159.

The occlusal backbone is simply the information associated with the entire occlusal surface after being stitched together from data from multiple frames of the occlusal surface. *See, e.g.*, EX1001, 4:20–43, 5:36–41; EX1003, ¶160.

As discussed in §VII(A)(1)(c), Zhang discloses that a processor generates a contiguous scan of the occlusal surface. EX1007, ¶¶[0041]–[0046], [0090], [0098]; EX1003, ¶161.

And as discussed above in §VII(A)(1)(i), Zhang discloses how the processor stitches together overlapping frames to create a 3D model of the occlusal surface. EX1007, ¶¶[0003], [0043]–[0048], [0055]–[0056], [0090]; EX1003, ¶162.

Zhang discloses the limitations of Claim 6—a processor generates information about the entire occlusal surface (occlusal backbone) by stitching together (matching) selected frames of the occlusal surface that were obtained from the contiguous scan of it. EX1003, ¶163.

7. Claim 10 (Preamble): A computer readable storage medium for generating an intra-oral scan of a dentition, wherein code stored in the computer readable storage medium, when executed by a processor, causes a system to:

Claim 10 is very similar to Claim 1, except that the processor language of Claim 1 has been replaced by a “computer readable storage medium” limitation. EX1003, ¶165.

The ’798 Patent describes “computer readable storage medium” as any of the typical types of devices that can store computer code, such as memory devices (e.g., RAM, ROM, EPROMS, etc.), hard disks, optical disks, and the like. EX1001, 13:11–24. It further describes how computer code stored on this medium can be executed by a computer processor to scan the mouth of a patient to generate a reconstructed 3D model of the patient’s teeth. *Id.*, 13:11–53. Because the processor executes the code stored on this “computer readable storage medium,” the change in claim language from a processor to a “computer readable storage medium” does not

meaningfully change the claimed system from that claimed in Claims 1–9. EX1003, ¶166.

Nonetheless, Zhang discloses system 100 comprised of computer 108 that includes a processor and “computer-usable medium 118,” which includes memory chips, hard drive, and the like. EX1007, ¶[0050]. This “computer-usable medium” can store “computer-readable instructions for execution by the computer 108 to perform the processes described [within the patent application].” *Id.* It can also “store data received from the scanner 102, store a three-dimensional model of the object 104, store computer code for rendering and display, as so forth.” *Id.* EX1003, ¶167.

The processes described in Zhang include generating an intra-oral scan of dentition. EX1007, ¶[0006] (“A method disclosed herein includes acquiring a data set from a surface of a dental object with a hand-held scanner from each one of a sequence of poses along a camera path...and reconstructing a three-dimensional model of the dental object using the optimized camera pose data and the plurality of data sets”). Dental objects include dentition. *Id.*, ¶[0038]. EX1003, ¶168.

Babayoff also discloses a system for intra-oral scanning comprised of a processor that executes code in memory. EX1008, 6:32–47, 28:8–24; EX1003, ¶169.

If the preamble is limiting, Zhang and Babayoff disclose a computer readable storage medium that stores computer code for generating an intra-oral scan of dentition. EX1003, ¶170.

- a. **[10.1]: generate a contiguous scan of an occlusal surface of at least a part of one arch of the dentition by capturing a plurality of partially overlapping image frames of the occlusal surface and stitching the overlapping image frames together to form a 3D model of the occlusal surface;**

This element is essentially identical to Element [1.9] described above in §VII(A)(1)(i). EX1003, ¶172.

For the reasons stated in §VII(A)(1)(i), Zhang discloses the requirements of Element [10.1]. *Id.*, ¶¶173–74.

- b. **[10.2]: remove image data of soft tissue from the overlapping image frames used to generate the occlusal scan based at least in part on an analysis of 3D data from the contiguous scan to distinguish between image data of the dentition and the image data of the soft tissue, wherein the soft tissue includes at least one selected from a group consisting of a tongue, a cheek, and a lip;**

This element is essentially identical to Element [1.4] described above in §VII(A)(1)(d). EX1003, ¶176.

For the reasons stated in §VII(A)(1)(d), Babayoff discloses the requirements of Element [10.2]. *Id.*, ¶¶177–78.

- c. **[10.3]: update the contiguous scan of the occlusal surface by restitching the overlapping image frames together after removing the image data of the soft tissue to form an updated 3D model of the occlusal surface; and**

This element is essentially identical to Element [1.11] described above in §VII(A)(1)(k). EX1003, ¶180.

For the reasons stated in §VII(A)(1)(k), Babayoff discloses the requirements of Element [10.3]. *Id.*, ¶¶181–82.

- d. **[10.4]: associate a scan of at least one additional surface to the contiguous scan of the occlusal surface by analyzing the scan data to identify a portion of the scan of the at least one additional surface that overlaps with a portion of the contiguous scan of the occlusal surface,**

This element is essentially identical to Elements [1.5] and [1.6] described above in §§VII(A)(1)(e) and (f). EX1003, ¶184.

For the reasons stated in §§VII(A)(1)(e) and (f), Zhang discloses the requirements of Element [10.4]. *Id.*, ¶¶185–86.

- e. **[10.5]: wherein the scan data includes a sequence of image frames including a plurality of image frames of the occlusal surface interspersed with a plurality of image frames of the at least one additional surface and**

This element is essentially identical to Element [1.7] described above in §VII(A)(1)(g). EX1003, ¶188.

For the reasons stated in §VII(A)(1)(g), Zhang discloses the requirements of Element [10.5]. *Id.*, ¶¶189–90.

- f. **[10.6]: determining a position of the scan of the at least one additional surface relative to the scan of the occlusal surface based on the identified overlapping portions.**

This element is essentially identical to Element [1.8] described above in §VII(A)(1)(h). EX1003, ¶192.

For the reasons stated in §VII(A)(1)(h), Zhang discloses the requirements of Element [10.6]. *Id.*, ¶¶193–94.

- 8. **Claim 11: The computer readable storage medium of claim 10, wherein the code, when executed by the processor, further causes the system to associate a plurality of scans of additional surfaces to the contiguous scan of the occlusal surface, wherein the plurality of scans of the additional surfaces includes a plurality of scans of labial surfaces and a plurality of scans of lingual surfaces.**

Claim 11 is substantively identical to Claim 2, except that it recites that the code in the computer readable storage medium, when executed by the processor, as opposed to just the processor alone, performs the function described in Claim 2. EX1003, ¶196.

For the reasons stated in §VII(A)(2), Zhang discloses the requirements of Claim 11. *Id.*, ¶¶197–98.

- 9. **Claim 12: The computer readable storage medium of claim 11, wherein the occlusal surface is imaged prior to the plurality of labial and lingual surfaces, and wherein the**

code, when executed by the processor, causes the system to display in real-time a three-dimensional representation of the dentition as the plurality of labial and lingual surfaces are imaged.

Claim 12 is substantively identical to Claim 4, except that it recites that the code in the computer readable storage medium, when executed by the processor, as opposed to just the processor alone, performs the function described in Claim 4. EX1003, ¶200.

For the reasons stated in §VII(A)(4), Zhang discloses the requirements of Claim 12. *Id.*, ¶¶201–02.

- 10. Claim 13: The computer readable storage medium of claim 12, wherein the code, when executed by the processor, causes the system to display in real-time the three-dimensional representation of the dentition by performing a coarse matching by matching features as the plurality of labial and lingual surfaces are imaged, and wherein the code, when executed by the processor, further causes the system to generate a three-dimensional reconstruction of the dentition based on a point cloud alignment after the plurality of labial and lingual surfaces are all imaged.**

Claim 13 is substantively identical to Claim 5, except that it recites that the code in the computer readable storage medium, when executed by the processor, as opposed to just the processor alone, performs the function described in Claim 5. EX1003, ¶204.

For the reasons stated in §VII(A)(5), Zhang discloses the requirements of Claim 11. *Id.*, ¶¶205–06.

11. Claim 14: The computer readable storage medium of claim 10,

Claim 14 is substantively identical to Claim 3, except that it recites that the code in the computer readable storage medium, when executed by the processor, as opposed to just the processor alone, performs the function described in Claim 3. EX1003, ¶207.

For the reasons stated in §VII(A)(3), Zhang discloses the requirements of Claim 14. *Id.*, ¶208.

- a. [14.1]: wherein the plurality of image frames of the occlusal surface from the scan of the at least one additional surface each overlap with the contiguous scan of the occlusal surface**

For the reasons already stated in §VII(A)(3)(a), Zhang discloses the requirements of Element [14.1]—that image frames from a scan of an additional surface can include image frames of the occlusal surfaces and that these image frames can overlap with images from the contiguous scan of the occlusal surface. EX1003, ¶210.

- b. [14.2]: wherein the plurality of image frames of the at least one additional surface includes image frames of a labial or lingual surface, and**

For the reasons already stated in §VII(A)(3)(b), Zhang discloses the requirements of Element [14.2]—that the scans of the additional surfaces include multiple images frames of the lingual and buccal/labial surfaces. EX1003, ¶212.

- c. **[14.3]: wherein the code, when executed by the processor, causes the system to use the plurality of image frames of the occlusal surface that is included in the scan of the at least one additional surface to determine a position of the image frames of the labial or lingual surface relative to the contiguous scan of the occlusal surface.**

For the reasons already stated in §VII(A)(3)(c), Zhang discloses the requirements of Element [14.3]—that the system uses multiple image frames of the scans of the occlusal, lingual, and labial/buccal surfaces to determine the position of the images relative to one another and the scan of the occlusal surface. EX1003, ¶214.

- 12. **Claim 15: The computer readable storage medium of claim 10, wherein the code, when executed by the processor, further causes the system to generate an occlusal backbone by matching selected frames of the contiguous scan of the occlusal surface that have an overlap based on an analysis of data.**

Claim 15 is substantively identical to Claim 6, except that it recites that the code in the computer readable storage medium, when executed by the processor, as opposed to just the processor alone, performs the function described in Claim 3. EX1003, ¶216.

For the reasons stated in §VII(A)(6), Zhang discloses the requirements of Element [15]. *Id.*, ¶217.

- 13. **Claim 17: The computer readable storage medium of claim 15 wherein the occlusal backbone is a first occlusal backbone, and wherein the code, when executed by the**

processor, further causes the system to generate a second occlusal backbone that is more accurate than the first occlusal backbone by linking other frames that are different from the selected frames to the first occlusal backbone.

This dependent claim requires that the system generate a second occlusal backbone that is more accurate than the first occlusal backbone by linking together other frames than were used to generate the first occlusal backbone. EX1003, ¶219.

As discussed in §§VII(A)(3)(b) and (12), Zhang discloses that a processor executing code from a computer storage medium that generates a first occlusal backbone from selected frames from the contiguous scan of the occlusal surface in order to create a 3D representation of the occlusal surface. *Id.*, ¶220.

Zhang further discloses that this coarse 3D representation, which it terms the “high-speed three-dimension model 340,” is then sent to a high-accuracy processing controller that executes code to create a more accurate 3D model of the surface. EX1007, ¶¶[0055]–[0056], Fig. 3. Zhang specifically states that separate image sets are used to create this higher-accuracy model of the occlusal surface. *Id.*, ¶[0056]. And Zhang states that these images are stitched together (or linked) to create this high-accuracy model. *Id.*; EX1003, ¶221.

Zhang discloses all the limitations of Claim 17—a processor executes code from a storage medium that generates a second occlusal backbone (the high-accuracy model) that is more accurate than the first occlusal backbone (the high-

speed three-dimensional model) using different frames that are linked (stitched) together. EX1003, ¶222.

- 14. Claim 18: The computer readable storage medium of claim 17, wherein the code, when executed by the processor, causes the system to remove the image data of the soft tissue from the contiguous scan of the occlusal surface by generating a third occlusal backbone by removing, from the second occlusal backbone, areas representing the soft tissue.**

This dependent claim requires that a processor executes code that creates a third occlusal backbone by removing soft tissue areas from the second occlusal backbone of Claim 17. EX1003, ¶224.

As described in §§VII(A)(1)(d) and (7)(b), Babayoff discloses how a processor executing code can remove soft tissue image data from image data that contains both hard and soft tissue information. EX1008, 2:1–18, 5:11–16, 8:30–66, 9:63–10:28, 22:11–61, 23:34–36, 24:25–47, 26:4–7. Thus, applying the technique described in Babayoff to the high-accuracy model (the second occlusal backbone) described in Zhang yields the third occlusal backbone required in this dependent claim. EX1003, ¶225.

Zhang discloses the elements of this claim. EX1003, ¶226.

- 15. Claim 19: The computer readable storage medium of claim 18, wherein the code, when executed by the processor, causes the system to remove the image data of the soft tissue based at least in part on the analysis of 3D data from the contiguous scan by removing the image data of the soft tissue based at least in part on the analysis of the 3D data**

and at least one selected from a group consisting of a difference in color and a difference in rigidity properties.

Claim 19 requires that the processor executes code that removes the soft tissue image data by analyzing the 3D data and differences in either the color or rigidity properties of the data. EX1003, ¶228.

As described in §VII(A)(1)(d), Babayoff uses differences in color to identify the soft tissue from the 3D data. EX1008, 5:11–16. These color differences are then used to distinguish soft tissue from hard tissue:

Then, in step 1320, an algorithm is applied to every pair of spatially adjacent data points, for example, wherein the value of the color parameter *c* of each of these points are compared one with the other, or with respect to some color criteria. When it is determined that the difference in color values is greater than a predetermined threshold, it is then assumed that the pair of data points are on opposite sides of a boundary between two tissues of different color, in particular between the edge of the tooth and the gum.

Id., 25:25–33; EX1003, ¶229.

Babayoff then states that this method can be used to remove the soft tissue from the hard tissue. EX1008, 26:4–8 (“The method according to this embodiment may be modified to separate the soft tissues from the hard tissues, once the demarcation line between the two tissues is known, as determined above.”); EX1003, ¶230.

Thus, Babayoff discloses at least the color-related limitations of this dependent claim. EX1003, ¶231.

16. Explanation of Why Claims 1–6, 10–15, and 17–19 Would Have Been Obvious

Claims 1–6, 10–15, and 17–19 would have been obvious over Zhang in view of Babayoff. EX1003, ¶232.

a. Difference between the claimed invention and the prior art.

As discussed in §VII(A), Zhang discloses all the features of the system of Claims 1–6, 10–15, and 17–19 with the exception of the removal of soft tissue image data in Elements/Claims [1.4], [1.10], [1.11], [10.2], [10.3], [18], and [20]. Babayoff discloses those missing limitations. EX1003, ¶233.

b. A POSITA would have had motivation to combine the disclosures of Zhang and Babayoff.

A POSITA would have had motivation to combine the system of Zhang with the processing of Babayoff to achieve a more accurate 3D representation of the teeth that did not include images of soft tissue in the patient’s mouth. EX1003, ¶234.

Zhang stated that there was a need in the dental industry for improved techniques to generate high-accuracy three-dimensional reconstructions. EX1008, ¶[0004]. They noted that a variety of artifacts from camera scans can result in errors in the reconstruction. *Id.*, ¶[0003]. And they further noted that their 3D reconstructions can include the gums and soft tissue. *Id.*, ¶[0014]. Such soft tissue

can be problematic if it blocks or prevents proper reconstruction of the hard surface of the teeth, which might occur if part of the patient's tongue or cheek appeared in the scan. EX1003, ¶235.

As Babayoff noted, dental practitioners need to prepare the most accurate reconstructions of dentition in order to properly provide treatment to their patients, such as better fitting orthodontics and dental prostheses. EX1008, 1:26–49, 1:59–67, 2:16–23. Reconstructions that include soft tissue such as a portion of the tongue or cheeks will lead to improperly fitting orthodontics and dental prostheses. One way to improve the 3D reconstruction was to identify and remove the soft tissue in the reconstruction. *Id.*, 24:25–47. EX1003, ¶¶236–38.

Thus, a POSITA would readily recognize that the system of Zhang could be improved to create more accurate orthodontics if soft tissue was removed from the 3D reconstructions. This is consistent with the principle behind Zhang, which was to create more accurate 3D reconstructions of teeth. The process described in Babayoff would be one such obvious choice available at that time. EX1003, ¶239.

c. A POSITA would have had a reasonable expectation of success based on the disclosures of Zhang and Babayoff and knowledge generally available in the art.

One of ordinary skill in the art would have had a reasonable expectation of success of making this combination work because both systems utilize hand-held scanning wands with cameras inserted into a patient's mouth to acquire multiple

images of dental features to create 3D representations of the patient's teeth. EX1007, ¶¶[0041]–[0043], Fig. 1; EX1008, 10:6–14, 11:36–40, Fig. 20. Both systems send the information from scanners to computers that process multiple, differing image frames to generate 3D reconstructions, which can be displayed on screens. EX1007, ¶¶[0041], [0043], [0045], [0049], [0054]–[0056], Fig. 1; EX1008, 28:8–40, Fig. 20. EX1003, ¶240.

The key teachings from Babayoff could be employed in Zhang by only modifying Zhang's software. Hardware changes would not be necessary. Zhang already determined how to reconstruct the images from the scanner into 3D representations of the patient's mouth. Modifying Zhang to achieve the claimed invention of the '798 Patent would only require modification of the existing software to differentiate the soft tissue from the dentition and then remove it, which is readily possible once the teachings of Babayoff are used. EX1003, ¶241.

The technology and the basic processes described in both references are the same, which creates a reasonable expectation of success that modifying the system of Zhang with the technique described in Babayoff would yield a successful result. *Id.*, ¶242.

Combining the disclosures of Zhang with Babayoff would only require the use of “known methods”—using each in the same way they were used as disclosed. None of the components would need to be used in an unexpected or unintended way.

Each would be fulfilling its original purpose and used in an expected way. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007) (“The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. . . . [W]hen a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a predictable result.”). EX1003, ¶243.

The combination of Zhang and Babayoff render obvious all the recited features of Claims 1–6, 10–15, and 17–19. *Id.*, ¶244.

B. Claims 7 and 16 Would Have Been Obvious Over Zhang in View of Babayoff and Fisker (Ground 2).

The following sections explain where each element of Claims 7 and 16 is found in the prior art of Zhang, Babayoff, and Fisker. EX1003, ¶¶37–42, 245.

1. Claim 7: The system of claim 6, wherein the processor is configured to detect the overlap based on noise characteristics of the data.

Petitioner explained in §§VII(A)(1) and (6) where the limitations of Claims 1 and 6, from which Claim 7 depends, can be found in Zhang and Babayoff, which are incorporated herein by reference. EX1003, ¶247.

Claim 7 further requires that the processor is configured to detect the overlapping image frames based on noise characteristics of the data. *Id.*, ¶249.

Fisker describes a near-threshold distance to determine what objects to disregard in an image when generating 3D models of a patient's mouth. This distance depends on the noise present in the images, which causes errors when trying to register or align overlapping images. The distance chosen attempts to minimize excluding appropriate information and maximize excluding inaccurate information. The near-threshold distance is set by the amount of noise in the image data. EX1009, 9:16–10:4, 53:17–29. EX1003, ¶250.

Fisker states that the methods and processes described in the patent are “implemented in software and carried out on a data processing system or other processing means caused by the execution of computer-executable instructions.” EX1009, 57:20–22; *see also* 38:21–26. EX1003, ¶251.

Fisker discloses that a processor uses noise characteristics of the image data to detect the overlap in the images. EX1003, ¶¶252–53.

2. Claim 16: The computer readable storage medium of claim 15, wherein the code, when executed by the processor, further causes the system to detect the overlap based on noise characteristics of the data.

Claim 16 is substantively identical to Claim 7, so for the same reasons discussed in §VII(B)(1), Zhang, Babayoff, and Fisker disclose all the limitations of Claim 16. EX1003, ¶255.

3. Explanation of Why Claims 7 and 16 Would Have Been Obvious

Claims 7 and 16 would have been obvious over Zhang in view of Babayoff and Fisker. EX1003, ¶256.

a. Difference between the claimed invention and the prior art.

As discussed in §VII(A), Zhang and Babayoff disclose all the features of the system of Claims 7 and 16 with the exception of the use of noise characteristics in the reconstruction process. Fisker discloses those missing limitations. EX1003, ¶257.

b. A POSITA would have had motivation to combine the disclosures of Zhang, Babayoff, and Fisker.

As discussed in §VII(A)(16)(b), a POSITA would have had a motivation to combine the system of Zhang with the processing of Babayoff to achieve a more accurate 3D representation of the teeth that did not have images of soft tissue in the patient's mouth. The addition of the noise-based processing of Fisker would have been another obvious improvement to the data processing to improve its accuracy and efficiency. EX1003, ¶258.

Zhang stated that there was a need in the dental industry for improved techniques to generate high-accuracy 3D reconstructions. EX1007, ¶[0004]. Zhang further recognized that “errors can result in a variety of reconstruction artifacts in a resulting three-dimensional model.” *Id.*, ¶[0003]. Zhang saw the need for “improved

global path optimization techniques suitable for use with data-intensive path optimizations typical of high-accuracy, three-dimensional dental reconstruction.” *Id.*, ¶[0004]. Babayoff disclosed the importance of differentiating between different surfaces in the mouth and restitching images together. EX1008, 8:14–22, 20:65–21:22, 23:48–24:5. Fisker recognized that the accuracy of the stitching process used to combine overlapping dental images into 3D models could be improved if objects closer than a near-threshold distance were excluded. EX1009, 9:16–10:4, 53:17–29. Images of objects closer than this near-threshold distance suffered from noise issues. *Id.* EX1003, ¶¶259–61.

Thus, a POSITA would readily recognize that the system of Zhang could be improved and better optimized if the noise characterization of Fisker was also employed to improve registration/alignment between representations. EX1009, 9:16–10:4 The process described in Fisker would be an obvious choice available at that time. EX1003, ¶262.

c. A POSITA would have had a reasonable expectation of success based on the disclosures of Zhang, Babayoff, and Fisker and knowledge generally available in the art.

One of ordinary skill in the art would have had a reasonable expectation of success of making this combination because all the systems utilized hand-held scanning wands with cameras inserted into a patient’s mouth to acquire multiple images of dental features to create 3D representations of the patient’s teeth. EX1007,

¶¶[0041]–[0043], Fig. 1; EX1008, 10:6–14, 11:36–40, Fig. 20; EX1009, 1:24–26, 7:19–22, 8:7–10, 25:18–20, 42:16–23, 43:1–5. All three systems send the information from scanners to computers that process multiple, differing image frames to generate 3D reconstructions. EX1007, ¶¶[0041], [0043], [0045], [0049], [0054]–[0056], Fig. 1; EX1008, 28:8–40, Fig. 20; EX1009, 57:19–26. EX1003, ¶263.

The key teachings from Fisker could be employed in Zhang/Babayoff by only modifying the software. Hardware changes would not be necessary. Zhang/Babayoff already determined how to reconstruct the images from the scanner into 3D representations of the patient’s mouth. Modifying them to achieve the claimed invention of Claims 7 and 16 would only require modifying the existing software to use image data noise characteristics to generate more accurate scans, which is readily possible once the teachings of Fisker are used. EX1003, ¶264.

The technology and the basic processes described in both references are the extremely similar, which creates a reasonable expectation of success that modifying the system of Zhang/Babayoff with the technique described in Fisker would yield a successful result. *Id.*, ¶265.

Combining the disclosures of Zhang with Babayoff and Fisker would only require the use of “known methods”—using each in the same way they were used as disclosed. None of the components would need to be used in an unexpected or

unintended way. Each would be fulfilling its original purpose and used in an expected way. *Id.* ¶266.

The combination of Zhang, Babayoff, and Fisker render obvious all the recited features of Claims 7 and 16. *KSR*, 550 U.S. at 416 (2007). EX1003, ¶267.

C. Claim 8 Would Have Been Obvious Over Zhang in View of Babayoff and Dillon (Ground 3).

The following sections explain where each element of Claim 8 is found in the prior art of Zhang, Babayoff, and Dillon. EX1003, ¶¶37–40, 43–44, 268.

1. Claim 8: The system of claim 1, further comprising:

Petitioner explained in §VII(A)(1) where the limitations of Claim 1, from which Claim 8 depends, can be found in Zhang and Babayoff, which are incorporated herein by reference. EX1003, ¶270.

a. [8.1]: a projector that projects interferometric fringes on an occlusal surface of at least a part of one arch of the dentition primarily along an anterior-posterior direction; and

Element [8.1] requires that the system have a projector that projects interferometric fringes on an occlusal surface of at least part of a dental arch primarily along the anterior-posterior direction. Dillon discloses such limitations. EX1003, ¶272.

In ¶[0017], Dillon states that the “embodiments described below...use structured illumination patterns generated by interferometric fringe projection.” EX1010; *see also* ¶¶[0018], [0020]. EX1003, ¶273.

Dillon uses a “fringe projector 18” to illuminate the surface of objects (such as teeth) with a “pattern of interference fringes 26.” EX1010, ¶[0019]. One such projector is wand 66, which can be used to obtain 3D data for a portion of a dental arch. *Id.*, ¶¶[0022]–[0023]. To do so, the clinician illuminates a portion of the occlusal surface of the arch with the structured light patten (interferometric fringes). *Id.*, ¶¶[0025]–[0026]. EX1003, ¶274.

Dillon discusses how the clinician starts at the patient’s left back molar and moves towards the front of the dental arch, i.e., along the anterior-posterior direction. EX1010, ¶[0025]. Dillon further notes how the interferometric fringes can be parallel to the direction of motion of the wand, i.e., also along the anterior-posterior direction. *Id.* EX1003, ¶275.

Dillon describes each of the limitations of Element [7.1]: (1) a projector that projects interferometric fringes (2) on an occlusal surface of at least part of a dental arch (3) primarily along the anterior-posterior direction. EX1003, ¶276.

b. [8.2]: an imaging sensor that is used to view the interferometric fringes,

Element [8.2] requires an imaging sensor that views the interferometric fringes. Dillon also meets this limitation. EX1003, ¶278.

Dillon describes an imager that images these fringes onto an array of photodetectors, such as a CCD array (an imaging sensor), that is passed along to a processor.

An image of the fringe pattern at the object 22 is formed by an imaging system or lens 30 onto an imager that includes an array of photodetectors 34. For example, the detector array 34 can be a two-dimensional charge coupled device (CCD) imaging array. An output signal generated by the detector array 34 is provided to a processor 38.

EX1010, ¶[0019], Fig. 1; EX1003, ¶279.

- c. **[8.3]: wherein the processor is further configured to generate the contiguous scan of the occlusal surface based on the interferometric fringes sensed by the imaging sensor.**

Element [8.3] requires that a processor generates a contiguous scan of the occlusal surface based on the interferometric fringes sensed by the imaging sensor. Dillon also meets this limitation. EX1003, ¶282.

As discussed in §VII(C)(1)(b), the imaging sensor sends data based on the interferometric fringes to the processor. EX1010, ¶[0019]. Dillon also notes how this system can scan the occlusal surface of the dental arch in a contiguous motion to generate a complete 3D data set of the dental arch using the interferometric fringe pattern. *Id.*, ¶¶[0023]–[0025]. EX1003, ¶283.

The processor uses the information from this contiguous scan to create the representation of the object surface (such as the occlusal surface). EX1010, ¶¶[0019]–[0021]; EX1003, ¶284.

Dillion discloses the limitations of Element [8.3]: (1) a processor (2) that generates a contiguous scan of the occlusal surface (3) based on interferometric fringes sensed by the image sensor. EX1003, ¶285.

2. Explanation of Why Claim 8 Would Have Been Obvious

Claim 8 would have been obvious over Zhang in view of Babayoff and Dillon. EX1003, ¶286.

a. Difference between the claimed invention and the prior art.

As discussed in §VII(A), Zhang and Babayoff disclose all the features of the system of Claim 8 with the exception of the use of interferometric fringes in the reconstruction process. Dillon discloses those missing limitations. EX1003, ¶287.

b. A POSITA would have had motivation to combine the disclosures of Zhang, Babayoff, and Dillon.

As discussed in §VII(A)(16)(b), a POSITA would have had a motivation to combine the system of Zhang with the processing of Babayoff to achieve a more accurate 3D representation of the teeth that did not have images of parts of the soft tissue in the patient's mouth. The addition of the interferometric fringes of Dillon would have been another obvious improvement to the processing of the data to improve its accuracy and efficiency. EX1003, ¶288.

Zhang stated that there was a need in the dental industry for improved techniques to generate high-accuracy 3D reconstructions. EX1007, ¶[0004]. Zhang further recognized that “errors can result in a variety of reconstruction artifacts in a

resulting three-dimensional model.” *Id.*, ¶[0003]. Zhang saw the need for “improved global path optimization techniques suitable for use with data-intensive path optimizations typical of high-accuracy, three-dimensional dental reconstruction.” *Id.*, ¶[0004]. Dillon recognized that the accuracy of the 3D models could be improved if the teeth were illuminated with interferometric fringes (using Accordion Fringe Interferometry (AFI)) “that can be used for high precision 3D measurements based on interferometric fringe projection.” EX1010, ¶¶[0016]–[0018]. EX1003, ¶289.

Thus, a POSITA would readily recognize that the system of Zhang could be improved to yield a better-optimized technique for dental reconstructions if the interferometric fringe illumination of Dillon was used. The process described in Dillon would be one such obvious choice available at that time. EX1003, ¶290.

c. A POSITA would have had a reasonable expectation of success based on the disclosures of Zhang, Babayoff, and Dillon and knowledge generally available in the art.

One of ordinary skill in the art would have had a reasonable expectation of success of making this combination because all the systems utilized hand-held scanning wands with cameras inserted into a patient’s mouth to acquire multiple images of the dental features to create 3D representations of the patient’s teeth. EX1007, ¶¶[0041]–[0043], Fig. 1; EX1008, 10:6–14, 11:36–40, Fig. 20; EX1010, ¶¶[0019]–[0022]. All three systems used external illumination to assist in the

scanning process. EX1007, ¶[0044]; EX1008, 8:30–35; EX1010, ¶¶[0019], [0022]. All three systems sent the information from scanners to computers to process the multiple, differing image frames to generate 3D reconstructions. EX1007, ¶¶[0041], [0043], [0045], [0049], [0054]–[0056], Fig. 1; EX1008, 28:8–40, Fig. 20; EX1010, ¶¶[0020]–[0021]. EX1003, ¶291.

The key teachings from Dillon could be employed in Zhang/Babayoff by only modifying the type of illumination and the software. Other hardware changes would not be necessary. Zhang/Babayoff already determined how to reconstruct the images from the scanner into 3D representations of the patient’s mouth using an external illumination source. Thus, modifying them to achieve the claimed invention of Claim 8 would only require modification of the particular illumination source and the software to interpret the interference fringes in order to generate more accurate scans, which is readily possible once the teachings of Dillon are used. EX1003, ¶292.

The technology and the basic processes described in the references are the same, which creates a reasonable expectation of success that modifying the system of Zhang/Babayoff with the technique described in Dillon would yield a successful result. *Id.*, ¶293.

Combining the disclosures of Zhang with Babayoff and Dillon would only require the use of “known methods”—using each in the same way they were used as disclosed. None of the components would need to be used in an unexpected or

unintended way. Each would be fulfilling its original purpose and used in an expected way. *Id.*, ¶294.

The combination of Zhang, Babayoff, and Dillon render obvious all the recited features of Claim 8. *KSR*, 550 U.S. at 416 (2007). EX1003, ¶295.

D. Claims 9 and 20 Would Have Been Obvious Over Zhang in View of Babayoff and Johnson (Ground 4).

The following sections explain where each element of Claims 9 and 20 is found in the prior art of Zhang, Babayoff, and Johnson. EX1003, ¶¶37–40, 45–47, 296.

- 1. Claim 9: The system of claim 1, wherein the processor is configured to remove the image data of soft tissue from the contiguous scan of the occlusal surface based at least in part on the analysis of 3D data from the contiguous scan by distinguishing between the image data of the dentition and the image data of the soft tissue based at least in part on a comparison of surface normals of 3D structures in the contiguous scan.**

Petitioner explained in §VII(A)(1) where the limitations of Claim 1, from which Claim 9 depends, can be found in Zhang and Babayoff, which are incorporated herein by reference. EX1003, ¶298.

Claim 9 further requires that the processor removes soft tissue image data from the occlusal scan based in part on an analysis of the differences between the surface normals of the 3D structures of the dentition and soft tissue. *Id.*, ¶299.

Johnson describes how to use surface normals to distinguish between dissimilar structures in a 3D image and to determine overlaps. *See, e.g.*, EX1011, Abstract, pp.1–47. Others have used this technique in intraoral applications. EX1012. EX1003, ¶¶300–04.

The software process described in Johnson could readily be used with the 3D data generated by Zhang/Babayoff to distinguish and then remove soft tissue from dentition in the contiguous scan of the occlusal surface, thereby satisfying the requirements of this claim. EX1003, ¶305.

2. **Claim 20: The computer readable storage medium of claim 10, wherein the code stored in the computer readable storage medium, when executed by the processor, cause the system to remove the image data of soft tissue from the contiguous scan of the occlusal surface based at least in part on the analysis of 3D data from the contiguous scan by distinguishing between the image data of the dentition and the image data of the soft tissue based at least in part on a comparison of surface normals of 3D structures in the contiguous scan.**

Claim 20 is identical to Claim 9, so for the same reasons discussed in §VII(D)(1), Zhang, Babayoff, and Johnson disclose all the limitations of Claim 20. EX1003, ¶306.

3. **Explanation of Why Claims 9 and 20 Would Have Been Obvious**

Claims 9 and 20 would have been obvious over Zhang in view of Babayoff and Johnson. *Id.*, ¶307.

a. Difference between the claimed invention and the prior art.

As discussed in §VII(A), Zhang and Babayoff disclose all the features of the system of Claims 9 and 20 with the exception of using surface normals in the reconstruction process. Johnson discloses those missing limitations. EX1003, ¶308.

b. A POSITA would have had motivation to combine the disclosures of Zhang, Babayoff, and Johnson.

As discussed in §VII(A)(16)(b), a POSITA would have had a motivation to combine the system of Zhang with the processing of Babayoff to achieve a more accurate 3D representation of the teeth that did not have images of the soft tissue in a patient's mouth. The addition of the surface normal technique of Johnson would have been another obvious improvement to the processing and accuracy of the data. EX1003, ¶309.

Johnson disclosed a technique for distinguishing between structures in a 3D model based on surface normals that could be employed to distinguish between soft tissue and dentition. EX1011. EX1003, ¶310.

Thus, a POSITA would readily recognize that the system of Zhang could be improved to yield a better optimized technique for dental reconstructions if the surface normal matching technique of Johnson was also employed. The process described in Johnson would be one such obvious choice available at that time.

Indeed, other intraoral scanning devices employed this technique. EX1012, 2:9–3:23. EX1003, ¶311.

c. A POSITA would have had a reasonable expectation of success based on the disclosures of Zhang, Babayoff, and Johnson and knowledge generally available in the art.

One of ordinary skill in the art would have had a reasonable expectation of success of making this combination because all the systems send the information from scanners to computers to process the multiple, differing image frames to generate 3D reconstructions. EX1007, ¶¶[0041], [0043], [0045], [0049], [0054]–[0056], Fig. 1; EX1008, 28:8–40, Fig. 20; EX1011, pp.1–9. EX1003, ¶312.

The key teachings from Johnson could be employed in Zhang/Babayoff by only modifying the software. Zhang/Babayoff already determined how to reconstruct the images from the scanner into 3D representations of the patient’s mouth. Modifying them to achieve the claimed invention of Claims 9 and 20 would only require modification of the existing software to compute surface normals and then use them to distinguish between the respective surfaces to generate more accurate scans, which is readily possible once the teachings of Johnson are used. EX1003, ¶313.

The technology and the basic processes described in the references are the same, which creates a reasonable expectation of success that modifying the system

of Zhang/Babayoff with the technique described in Johnson would yield a successful result. *Id.*, ¶314.

Combining the disclosures of Zhang with Babayoff and Johnson would only require the use of “known methods”—using each in the same way they were used as disclosed. None of the components would need to be used in an unexpected or unintended way. Each would be fulfilling its original purpose and used in an expected way. *Id.*, ¶315.

The combination of Zhang, Babayoff, and Johnson render obvious all the recited features of Claims 9 and 20. *KSR*, 550 U.S. at 416 (2007). EX1003, ¶316.

VIII. OTHER CONSIDERATIONS

A. Any Purported Secondary Considerations Evidence Does Not Overcome the Strong Evidence of the Obviousness of the Claims

All elements of Claims 1–20 are known in the art, and any differences between the claims and the prior art of Zhang, Babayoff, Fisker, Dillon, and Johnson would have been obvious to a POSITA based on the disclosures of the applied references and the knowledge in the art. EX1003, ¶317.

Petitioners are not aware of any secondary considerations evidence bearing any nexus to the purported claimed invention. Any purported evidence of secondary considerations that Patent Owner may present in this proceeding would be insufficient to overcome the strong evidence of obviousness of Claims 1–20. *Id.*, ¶318.

B. The Board Should Not Deny This Petition Under §314(a)

Petitioners hereby stipulates that, should the Petition be granted, Petitioners will not pursue in the Related Litigation the same grounds that are raised or could have reasonably been raised in this Petition pursuant to *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020). The Director has stated that “the PTAB will not discretionarily deny institution of an IPR” in view of such a stipulation. Katherine K. Vidal, Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation (June 21, 2022) at 3 and n.3 (discussing *Sotera*); *see id.* at 7–9.

Accordingly, Petitioners’ stipulation is dispositive in establishing that institution should not be discretionarily denied under 35 U.S.C. §314(a).

C. The Board Should Not Deny This Petition Under §325(d)

There is no reason to deny institution under §325(d). The totality of the *Becton, Dickinson* factors favor institution. Specifically, none of the cited references herein is the same or substantially the same art previously addressed by the examiner during prosecution of the application.

IX. CONCLUSION

For at least the foregoing reasons, Claims 1–20 of the '798 Patent are unpatentable. Since Petitioners have shown the claims to be *prima facie* obvious, Petitioners have also shown a likelihood of success on the merits. Therefore, this Petition should be granted, and the Board should institute trial.

Date: February 15, 2024

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APPENDIX A—LIST OF EXHIBITS

EXHIBIT	DESCRIPTION
1001	U.S. Patent No. 11,234,798, issued on February 1, 2022 to R. Dillon <i>et al.</i> (“the ’798 Patent”)
1002	File History of U.S. Patent Application No. 16/160,230, filed on October 15, 2018
1003	Declaration of Dr. Eli Saber
1004	<i>Curriculum Vitae</i> of Dr. Eli Saber
1005	Declaration of Dr. Sylvia Hall-Ellis
1006	<i>Curriculum Vitae</i> of Dr. Sylvia Hall-Ellis
1007	PCT Publication No. WO 2010/077380A2, published on July 8, 2010, by H. Zhang, <i>et al.</i> (“Zhang”)
1008	Babayoff, U.S. Patent No. 7,698,068B2, issued on April 13, 2010 to N. Babayoff (“Babayoff”)
1009	PCT Publication No. WO 2013/010910A1, published on January 24, 2013, by R. Fisker, <i>et al.</i> (“Fisker”)
1010	U.S. Patent Publication No. 2012/0062701A1, published on March 15, 2012, by R. Dillon, <i>et al.</i> (“Dillon”)
1011	Johnson, “Spin-Images: A Representation for 3-D Surface Matching,” published on August 13, 1997 (“Johnson”)
1012	PCT Publication No. WO 2014/049049A1, published on April 3, 2014, by C. Van Lierde, <i>et al.</i>
1013	Defendant’s Answer to Plaintiff’s Second Amended Complaint, Defenses, and Counterclaims, filed on February 16, 2023 in <i>3Shape A/S v. Carestream Dental, LLC et al</i> , Civ. Action No. 1:22-cv-01829

Petition for *Inter Partes* Review of U.S. Patent No. 11,234,798

EXHIBIT	DESCRIPTION
1014	Counterclaim Defendant 3Shape A/S' Opening Brief on Claim Construction, filed on October 27, 2023 in <i>3Shape A/S v. Carestream Dental, LLC et al</i> , Civ. Action No. 1:22-cv-01829
1015	DITC's Opening Claim Construction Brief Regarding the DITC Asserted Patents, filed on October 27, 2023 in <i>3Shape A/S v. Carestream Dental, LLC et al</i> , Civ. Action No. 1:22-cv-01829

CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. §42.24

I hereby certify that the word count for the foregoing Petition totals 13,980 words, excluding the parts which are exempted by 37 C.F.R. §42.24(a)(1).

Date: February 15, 2024

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that on this 15th day of February, 2024, a true and correct copy of the foregoing **PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 11,234,798 B2 UNDER 35 U.S.C. §§311–19 and 37 C.F.R. §42.100 *et seq.* and EXHIBITS 1001–1015** are being served by overnight UPS on the correspondence address of record and the Assignee as follows:

USPTO Correspondence Address for US Patent 11,234,798:
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