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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DENTAL IMAGING TECHNOLOGIES CORPORATION
Petitioner

v.

3SHAPE A/S
Patent Owner

Case No. IPR2023-00411
Patent 11,368,667

PATENT OWNER'S PRELIMINARY RESPONSE

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I. INTRODUCTION

Patent Owner, 3Shape A/S (“3Shape” or “Patent Owner”), submits this Patent Owner’s Preliminary Response to the Corrected Petition for *Inter Partes* Review (“Petition” or “Pet.”) filed by DENTAL IMAGING TECHNOLOGIES CORPORATION (“DITC” or “Petitioner”) against U.S. Patent No. 11,368,667 (EX1001, “the ’667 Patent”). This paper is timely filed pursuant to 37 C.F.R. § 42.207(b) and the Notice of Filing Date Accorded to Petition and Time for Filing Patent Owner Preliminary Response (Paper 5).

Petitioner fails to establish a reasonable likelihood that it would prevail with respect to any challenged claim of the ’667 Patent. The first purported ground for unpatentability is that Babayoff, Zhang, and Knighton renders obvious Claims 1-8, 13-16, 18-22, 26, and 28-29. This ground is deficient for at least three reasons. First, Petitioner fails to demonstrate that any of the cited references disclose or suggest (i) a “time-varying illumination pattern,” (ii) “a probe light with a plurality of configurations, a (iii) “handheld intraoral scanner comprising ... a hardware processor [located within the intraoral scanner,] configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; and record images of the object with the different colors by recording different images by the at least one camera at the different times,” or (iv) a “handheld intraoral scanner comprising ... a hardware processor, located within

the intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; record images of the object with the different colors by recording different images by the at least one camera at the different times; process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and transmit, via a wireless connection, the data for the 3D geometry at a reduced data rate in comparison with transmission of the raw 3D data.” Second, Petitioner bears the burden of providing a reason with rational underpinnings as to why it would have been obvious to modify Babayoff to arrive at the claimed invention. Petitioner’s rationale for modifying Babayoff is negated by the Zhang disclosure and Petitioner’s proposed combination device. Further, a POSA would not have had a reasonable expectation of combining Babayoff, Zhang, and Knighton to successfully arrive at the claimed invention. Thus, the Board should deny institution of Ground 1.

The second purported ground for unpatentability is that Babayoff, Zhang, Knighton, and Serra render obvious Claims 12, 17, and 27. For the reasons presented with respect to the first ground, the Board should also deny institution of Ground 2.

Finally, the Board should exercise its discretion under 35 U.S.C. § 325(d) to deny this Petition. Denial is appropriate here based on the two-step framework

articulated in *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 7-8 (PTAB Feb. 13, 2020) (precedential). The first *Advanced Bionics* step is satisfied because the Petition relies on substantially the same prior art and arguments that were previously considered by the Office during prosecution. Second, Petitioner has not met its burden to show that the Examiner erred.

Patent Owner respectfully requests that the Board denies institution of this Petition.

II. STATEMENT OF THE PRECISE RELIEF REQUESTED

Patent Owner requests that the Board deny institution of the Petition with respect to all challenged claims and all asserted grounds. A full statement of the reasons for the relief requested is set forth in Sections III.-VI below.

III. THE '667 PATENT

The '667 Patent contains thirty-one (31) claims. EX1001 at 37:24-40:55. Claims 1, 14, and 26 are the sole independent claims. *Id.* Claims 2-13, 15-25, and 27-31 depend either directly or indirectly from Claims 1, 14, or 26. *Id.* Independent Claims 1, 14, and 26 recite:

1. A handheld intraoral scanner for determining the 3D geometry and color of at least a part of the surface of an object in an oral cavity, the intraoral scanner comprising:
a tip configured to be inserted into the oral cavity;

at least one camera accommodating an array of sensor elements;

a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern;

an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;

one or more motion sensors located on the intraoral scanner to measure three-dimensional motion of the intraoral scanner, wherein the intraoral scanner is wireless; and

a hardware processor, located within the intraoral scanner, configured to:

selectively switch a color of the probe light to illuminate the object with different colors at different times; and

record images of the object with the different colors by recording different images by the at least one camera at the different times.

14. A handheld intraoral scanner for determining the 3D geometry and color of at least a part of the surface of an object in an oral cavity, the intraoral scanner comprising:

- a tip configured to be inserted into the oral cavity;
- at least one camera accommodating an array of sensor elements;
- a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern;
- an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;
- one or more motion sensors located on the intraoral scanner to measure three-dimensional motion of the intraoral scanner; and
- a hardware processor configured to:
 - selectively switch a color of the probe light to illuminate the object with different colors at different times; and

record images of the object with different colors by
recording different images by the at least one
camera at the different times;
process raw 3D data into data for the 3D geometry,
wherein the raw 3D geometry is based on the
plurality of 2D images; and
transmit, via a wireless connection, the data for the
3D geometry at a reduced data rate in
comparison with transmission of the raw 3D
data.

26. A handheld intraoral scanner for determining the 3D
geometry and color of at least a part of the surface of an
object in an oral cavity, the intraoral scanner comprising:
a tip configured to be inserted into the oral cavity;
at least one camera accommodating an array of sensor
elements;
a pattern generator configured to generate, using a light
source, a probe light with a plurality of
configurations in the form of a time-varying
illumination pattern;
an optical system configured to transmit the probe light,
via the tip, towards the object along an optical path
thereby illuminating at least a part of the object
with the time-varying illumination pattern, and to
transmit at least a part of the light returned from
the object to the at least one camera to form a

plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;

one or more motion sensors located on the intraoral scanner to measure three-dimensional motion of the intraoral scanner; and

a hardware processor configured to:

selectively switch a color of the probe light to illuminate the object with different colors at different times; and

record images of the object with different colors by recording different images by the at least one camera at the different times.

Id., at 37:24-56, 38:37-39:13, 40:1-27.

IV. CLAIM CONSTRUCTION

The standard for claim construction in *inter partes* review is the “ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b). Petitioner states “for purposes of this proceeding, all terms should be given their ordinary and customary meaning.” Pet. at 14. Petitioner is not taking consistent positions between this proceeding and the parallel district court proceeding. Quite the contrary, Petitioner has alleged constructions and indefiniteness in the parallel proceeding. *See* EX2005. It is improper to construe the terms one way for invalidity and another for infringement. *Data Engine Techs. LLC v. Google LLC*,

10 F.4th 1375, 1381 (Fed. Cir. 2021). Patent Owner here maintains the claim construction positions it has taken in the parallel district court proceeding.

Compare below with EX2005.

- A. “handheld intraoral scanner comprising ... a hardware processor [located within the intraoral scanner,] configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; and record images of the object with the different colors by recording different images by the at least one camera at the different times” (Claims 1, 26)**

The hardware processor of Claims 1 and 26 have at least two specific functions: (1) selectively switch a color of the probe light to illuminate the object with different colors at different times; and (2) record images of the object with the different colors by recording different images by the at least one camera at the different times. Further, the claimed hardware processors of Claims 1 and 26 are physically incorporated within the intraoral scanner.

- B. “handheld intraoral scanner comprising ... a hardware processor, located within the intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; record images of the object with the different colors by recording different images by the at least one camera at the different times; process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and transmit, via a wireless connection, the data for the 3D geometry at a reduced data rate in comparison with transmission of the raw 3D data” (Claim 14)**

The hardware processor of Claim 14 has at least four specific functions: (1) selectively switch a color of the probe light to illuminate the object with different

colors at different times; (2) record images of the object with the different colors by recording different images by the at least one camera at the different times; (3) process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 3D images; and (4) transmit, via a wireless connection, the data for the 3D geometry at a reduced data rate in comparison with transmission of the raw 3D data. Further, the claimed hardware processor of Claim 14 is physically incorporated within the intraoral scanner.

C. “time-varying illumination pattern” (Claims 1, 14, 26)

The specification of the ’667 Patent defines “time varying illumination pattern” as “[a] pattern that varies in time, i.e. the embedded spatial structure varies in time.” EX1001, 4:64-66. Further, “illumination pattern” is defined as a “light signal comprising an embedded spatial structure in the lateral plane.” *Id.*, 4:61-63. Thus, the meaning of this claim term is a light signal comprising an embedded spatial structure in the lateral plane, wherein the embedded spatial structure of the light signal varies in time.

This construction of the claim term is consistent with statements made by 3Shape during prosecution of ancestral U.S. Patent No. 10,326,982, wherein the term was first introduced into the patent family prosecution history. *See In re Rambus Inc.*, 694 F.3d 42, 48 (Fed. Cir. 2012) (“unless otherwise compelled ... the same claim term in the same patent or related patents carries the same construed

meaning,” quoting *Omega Eng’g Inc. v. Raytek Corp.*, 334 F.3d 1314, 1334 (Fed. Cir. 2003)).

Here, the Office had asserted that U.S. Publ. No. 2007/0041729 (“Heinz”) “explicitly [taught] wherein the plurality of configurations is in the form of a time-varying illumination pattern, such that the 3D geometry is determined based on the time-varying illumination pattern” as recited in the then-pending claims. EX2001, at 5. In response, 3Shape filed a Proposed Amendment and an Interview Summary stating that

the radiation incident on the object 804 [in Heinz] is constant, and the light reflected back to the sensor may vary with time based on the movement of the object itself. This is in contrast to claim 2, which states that the probe light *illuminating the object* includes a plurality of configurations in the form of a time-varying illumination pattern. In Heinz, the radiation incident on the object 804 does not include a plurality of configurations in the form of a time-varying illumination pattern.

EX2002, at 2. The Office then accepted 3Shape’s proposed claim amendments and arguments in an Examiner’s amendment. EX2003, at 6-7.

Thus, 3Shape successfully distinguished its claimed invention as providing an illumination pattern (*i.e.*, an embedded spatial structure of the light signal) that varies over time, over Heinz which purportedly discloses (i) moving an

illuminating fiber **802** providing a multimode interference pattern over a surface **804** and/or (ii) moving the surface **804**. EX2004, at 7, ¶[0069]. Additionally, based on 3Shape’s prosecution statements, “time-varying illumination pattern” as recited in the patented claims does not encompass Heinz’s moving an illumination pattern across an object being scanned. *See General Electric Company v. Rolls-Royce PLC*, IPR2016-00528, Paper 29 (PTAB July 26, 2017) (panel adopted patent owner’s claim construction based on the prosecution history and narrowing amendments made by the applicant during prosecution); *see also The Scotts Company LLC v. Encap LLC*, IPR2013-00110, Paper 79 at 13-16 (PTAB June 24, 2014) (panel reviewed prosecution history to inform claim construction); *Microsoft Corp. v. Proxycom, Inc.*, 789 F.3d 1292, 1298 (Fed. Cir. 2015) (“The PTO should also consult the patent’s prosecution history in proceedings in which the patent has been brought back to the agency for a second review.”); *In re NTP, Inc.*, 654 F.3d 1279, 1288 (Fed. Cir. 2011) (the Board’s construction “cannot be divorced from the specification and the record evidence”); *In re Man Machine Interface Tech. LLC*, 822 F.3d 1282, 1286 (Fed. Cir. 2016). Petitioner failed to address the impact of such prosecution history on construing this claim term. Pet. at 5.

Finally, 3Shape’s construction of this claim term is consistent with their parallel district court proceeding construction. EX2005. As explained in sections

V.A.-B., *infra*, Petitioner fails to demonstrate that any of Babayoff, Zhang, Knighton, and Serra disclose such claim limitation.

D. “the object” is “an object in an oral cavity” (Claims 1, 14, and 26)

The term “the object” as recited in Claims 1, 14, and 26 finds antecedent basis in the recitation of “an object in an oral cavity” in Claims 1, 14, and 26, respectively. Additionally, the recitation of “the object” in Claims 5 and 22 refers to “an object in an oral cavity” as recited in Claims 1 and 14, respectively. Accordingly, the term “the object” in Claims 1, 14, and 26 should be construed to be “the object in an oral cavity” because the use of antecedent-basis language like “the” narrows the term “the object” to encompass only objects in an oral cavity. *Evolution Concepts, Inc. v. HOC Events, Inc.*, 22 F.4th 1361, 1366 (Fed. Cir. 2022).

E. “a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern” (Claims 1, 14, and 26)

Petitioner argued that the recited phrase *is* subject to 35 U.S.C. § 112(6) in the parallel district court proceeding, but asks the Board to construe this term according to its ordinary and customary meaning. EX2005, at 15; Pet. at 14. 3Shape believes and agrees that the ordinary and customary meaning is the correct construction of this claim phrase.

The decision on whether to institute trial is not dependent on the constructions that the parties offered in the parallel litigation. Nevertheless, Petitioner fails to demonstrate a reasonable likelihood of success under any construction whether it be its asserted constructions here or its asserted constructions in the district court.

V. ARGUMENT

Institution should be denied because Petitioner has failed to establish a reasonable likelihood that the Petitioner would prevail with respect to any ground or any challenged claim. There are at least three reasons to deny institution. First, there is at least one limitation missing in the combination of references. Second, Petitioner has not established a motivation with reasonable underpinnings to combine the asserted art to arrive at the claimed invention. Third, Petitioner has failed to provide evidence that a POSA would have had a reasonable expectation of success in combining the art to arrive at the claimed invention.

The Director may not authorize an *inter partes* review to be instituted unless the Director determines that the information presented in the petition filed under section 311 and any response filed under section 313 shows that there is a reasonable likelihood that the Petitioner would prevail with respect to at least one of the claims challenged in the petition. 35 U.S.C. § 314(a); 37 C.F.R. § 42.108(c).

The Petition sets forth three grounds of alleged unpatentability. Pet. at 1-2. In “Ground 1,” Petitioner alleges that Claims 1-8, 13-16, 18-22, 26, and 28-29 are unpatentable under 35 U.S.C. § 103(a) as obvious over Babayoff, Zhang, and Knighton. *Id.* In “Ground 2,” Petitioner alleges that Claims 12, 17, and 27 are unpatentable under 35 U.S.C. § 103(a) as obvious over Babayoff, Zhang, Knighton, and Serra. *Id.*

To establish obviousness of a claimed invention under 35 U.S.C. § 103(a), Petitioner must establish that “the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person of ordinary skill in the art to which the subject matter pertains.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007) (citing *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1 (1966)). A patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was known, independently, in the prior art. *See KSR*, 550 U.S. at 418.

Further, the appropriate inquiry into obviousness requires that “one must have a motivation to combine accompanied by a reasonable expectation of achieving what is claimed in the patent-at-issue.” *Intelligent Bio-Systems, Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367 (Fed. Cir. 2016). Thus, the requirement for a motivation to combine references is separate from the

requirement for a person of ordinary skill in the art to have a reasonable expectation of success in combining the cited references to meet the limitations of the claimed invention. *Id.* See also *In re Merck & Co., Inc.*, 800 F.2d 1091 (Fed. Cir. 1986).

“[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006); see also *KSR*, 550 U.S. at 418. The Petition does not provide articulated reasoning based on rational underpinnings for why one of ordinary skill in the art would have modified the asserted art to arrive at the claimed invention.

Petitioner fails to demonstrate a reasonable likelihood of success with respect to all challenged claims and all grounds presented in the Petition. The deficiencies of the Petition are discussed below.

A. Petitioner fails to demonstrate a reasonable likelihood that the Petitioner would prevail with respect to at least one of the claims challenged in Ground 1

Petitioner fails to establish a reasonable likelihood that the Petitioner would prevail with respect to at least one of the claims challenged in Ground 1 based on Babayoff, Zhang, and Knighton for at least the following reasons. First, Petitioner fails to demonstrate that Babayoff, Zhang, and Knighton or any combination

thereof discloses each of the limitations of the independent claims. Second, Petitioner fails to demonstrate that there would have been motivation for a POSA to combine Babayoff with Zhang and Knighton to arrive at the claimed invention. Third, Petitioner fails to demonstrate that a POSA would have a reasonable expectation of success in combining Babayoff, Zhang, and Knighton to arrive at the claimed invention.

1. None of the asserted references, either alone or in combination, disclose or suggest each and every limitation of the challenged claims.

As discussed in further detail below, Petitioner fails to demonstrate that the cited references, either alone or in combination, disclose or suggest each and every limitation of the challenged claims. In particular, Petitioner has failed to demonstrate that the cited references, either alone or in combination, disclose or suggest the following claim limitations: (i) a “time-varying illumination pattern,” (ii) “a probe light with a plurality of configurations, a (iii) “handheld intraoral scanner comprising ... a hardware processor [located within the intraoral scanner,] configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; and record images of the object with the different colors by recording different images by the at least one camera at the different times,” or (iv) a “handheld intraoral scanner comprising ... a hardware processor, located within the intraoral scanner, configured to: selectively switch a

color of the probe light to illuminate the object with different colors at different times; record images of the object with the different colors by recording different images by the at least one camera at the different times; process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and transmit, via a wireless connection, the data for the 3D geometry at a reduced data rate in comparison with transmission of the raw 3D data.”

a. None of the asserted references disclose a “time-varying illumination pattern.”

As admitted in the Petition, “Babayoff does not explicitly disclose that the light pattern is time-varying.” Pet. at 27. Petitioner also provides no evidence or arguments to infer that Babayoff implicitly discloses that its purported light pattern is time-varying.

In an attempt to address Babayoff’s deficiency, Petitioner asserts that “[t]he *illumination pattern* of Zhang that is *shifted across the scene* at time intervals ... is a *time-varying illumination pattern*.” Pet. at 28 (emphasis in original). To support this assertion, the Petitioner argues that “a time varying pattern can be created by moving a pattern across the object being scanned” and references the ’667 Patent specification. Pet. at 28. However, as discussed in 3Shape’s Responsive Claim Construction Brief in the parallel proceeding, Petitioner’s reliance on specific specification citations improperly reads out the recitation of “illumination” in “time-varying illumination pattern.” EX2005 at 9. Moreover,

the Petitioner improperly seeks to construe the term without regard to the other more relevant portions of the specification. For example, the Petition does not cite the “Definitions” section of the specification which provides an explicit definition for “time varying illumination pattern.” EX1001, 4:62-64.

The Petition also does not suggest that any of the file histories of related patents in the family had been considered or reviewed for claim construction. Heinz’s disclosure of moving an illumination pattern across an object being scanned (in the file history of related U.S. Patent No. 10,326,982) is similar to Zhang’s disclosure of a “stripe pattern that is shifted across the scene.” The file history supports 3Shape’s construction of a “time-varying illumination pattern” because Zhang’s disclosure of a “pattern that is shifted across the scene,” like Heinz’s disclosure, is precisely the type of embodiment ***not*** encompassed by the claimed phrase when it is properly construed. *See* Section IV.C. above. For at least these reasons, Petitioner’s cursory claim construction analysis is incomplete and incorrect, and Zhang’s disclosure does not teach or suggest a “time-varying illumination pattern.”

The Petitioner does not assert that Knighton cures this deficiency of Babayoff. As such, none of Babayoff, Zhang, and Knighton disclose or suggest a time-varying illumination pattern as construed above in Section IV.C.—a light signal comprising an embedded spatial structure in the lateral plane, wherein the

embedded spatial structure of the light signal varies in time. Accordingly, the combination of Babayoff, Zhang, and Knighton does not teach or suggest all of the claimed limitations of independent Claims 1, 14, and 26. For at least the same reasons, the combination of Babayoff, Zhang, and Knighton does not teach or suggest all of the claimed limitations of Claims 2-8, 13, 15-16, 18-22, and 28-29, which directly or indirectly depend from Claims 1, 14, and 26, respectively.

- b. None of the asserted references disclose “handheld intraoral scanner comprising ... a hardware processor [located within the intraoral scanner,] configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; and record images of the object with the different colors by recording different images by the at least one camera at the different times” (Claims 1, 26)**

As admitted in the Petition, “Babayoff does not explicitly disclose that the *processor 24* is local on the intraoral scanner.” Pet. at 44 (emphasis in original). Petitioner also provides no evidence or arguments to infer that Babayoff implicitly discloses that its hardware processor is located within its handheld device.

- i. Babayoff does not implicitly disclose that its hardware processor is located within its handheld device.**

Babayoff is a published U.S. patent application that is a continuation of U.S. Appl. No. 11/154,520. EX1005, face page. Accordingly, Babayoff’s specification is identical to that of U.S. Appl. No. 11/154,520.

Babayoff is also one of many publications and patents that claim a priority benefit to ancestral non-provisional U.S. Appl. No. 11/154,520, and two provisional applications: U.S. Prov. Appl. Nos. 60/580,109 and 60/580,108. These patent applications were determined not to explicitly or implicitly disclose “a handheld device comprising ... a processor” *See 3Shape A/S et al. v. Align Technology, Inc.*, IPR2019-00155, Paper 9 at 8-21 (PTAB June 7, 2019) (Board construed the term “a handheld device comprising ... a processor” as a handheld device that physically incorporates a processor) and 17-22 (Board determined that the claimed term lacked written descriptive support in priority applications).

Accordingly, neither Babayoff nor its priority applications explicitly or implicitly disclose “a handheld device comprising ... a processor ...”.

- ii. **Secondary references do not disclose “handheld intraoral scanner comprising ... a hardware processor [located within the intraoral scanner,] configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; and record images of the object with the different colors by recording different images by the at least one camera at the different times.”**

Petitioner relies on Knighton to cure deficiencies of Babayoff: “Knighton teaches that the processing to determine the 3D geometry can be performed *local* to the hand-held scanning device using the *processor 301* that is *internal* to the hand-held scanning device.” Pet. at 45. Petitioner relies on various citations to

Knighton to support its statement that “Knighton ... performs similar processing as Babayoff and Zhang—determining depth values based on a plurality of 2D images and producing a 3D geometry representation of the surface of the object.” *Id.* at 44-45 (listing Knighton citations: [0024]-[0025], [0029], [0033], [0038]-[0041], [0045], [0049], [0052], [0054], [0093], FIGS. 1, 3). However, none of these citations to Knighton discuss a handheld intraoral scanner comprising a hardware processor located within the intraoral scanner that is capable of (i) selectively switching a color of the probe light to illuminate the object with different colors at different times or (ii) recording images of the object with the different colors by recording different images by the at least one camera at the different times. That is, the Petition fails to demonstrate that Knighton discloses or suggests physically incorporating a hardware processor comprising the two claimed functions into a handheld intraoral scanner. Zhang also does not disclose or suggest physically incorporating a hardware processor comprising the two claimed functions into a handheld intraoral scanner.

To be clear, the claimed hardware processor of Claims 1 and 26 must at least (i) selectively switch a color of the probe light to illuminate the intraoral object with different colors at different times, and (ii) record images of the object with the different colors by recording different images by the at least one camera at the different times. The hardware processor of Claims 1 and 26 may be configured to

perform additional tasks. For example, dependent Claim 6 further states that the claimed hardware processor is also configured to (iii) process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images, and (iv) transmit, via wireless connection, the processed data for the 3D geometry. Despite the recitation of all these hardware processor tasks, neither Petitioner nor its expert discuss how the specific claimed hardware processor—with all of its unique color-switching, recording, processing, and wireless transmission demands—can be placed within a handheld intraoral scanner to arrive at an operative device that not only determines 3D geometry but also color.

Thus, for at least these reasons, the combination of Babayoff, Zhang, and Knighton does not teach or suggest all of the claimed limitations of Claims 2-8, 13, and 28-29, which directly or indirectly depend from Claims 1 and 26.

- c. **None of the asserted references disclose “handheld intraoral scanner comprising ... a hardware processor, located within the intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; record images of the object with the different colors by recording different images by the at least one camera at the different times; process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and transmit, via a wireless connection, the data for the 3D geometry at a reduced data rate in comparison with transmission of the raw 3D data” (Claim 14)**

For the same reasons provided above in Section V.A.1.b., none of the asserted references disclose a “handheld intraoral scanner comprising ... a hardware processor, located within the intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; record images of the object with the different colors by recording different images by the at least one camera at the different times; process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and transmit, via a wireless connection, the data for the 3D geometry at a reduced data rate in comparison with transmission of the raw 3D data” as recited in Claim 14. That is, none of the asserted references disclose or suggest physically incorporating a hardware processor comprising the four recited functions into a handheld intraoral scanner. And, for at least the same reasons, the combination of Babayoff, Zhang, and Knighton does not teach or suggest all of the

claimed limitations of Claims 15-16, 18-22, which directly or indirectly depend from Claim 14.

d. Petitioner impermissibly relies on the same Zhang disclosure to allegedly satisfy two distinct elements recited in the claims.

In the claims of the '667 Patent, the recited “probe light with a plurality of configurations” is a distinct claim element from the recited “time-varying illumination.” For the reasons discussed below, it is impermissible for Petitioner to rely on the same “stripe pattern that is shifted across the scene” disclosed by Zhang to somehow satisfy both the claimed “probe light with a plurality of configurations” and “time-varying illumination” elements.

i. The claimed “probe light with a plurality of configurations” is a distinct element from the claimed “time-varying illumination pattern.”

Claims 1, 14, and 26 recite “a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern.” EX1001, 37:33-35, 38:53-55, 40:7-9. As discussed above, the illumination pattern is an embedded spatial structure of the light signal that varies with time. The probe light has “a plurality of configurations” and is transmitted “through a tip of intraoral scanner inserted into the oral cavity, towards the object along an optical path, thereby illuminating at least a part of the object with the time-varying illumination pattern.” *Id.* That is, the probe light is used to

illuminate at least part of the object being scanned with the time-varying illumination pattern. Thus, neither the probe light nor the plurality of configurations of the probe light are the time-varying illumination pattern itself. This is apparent from the plain language of the claim.

That the recited “probe light with a plurality of configurations” and the recited “time-varying illumination pattern” are distinct claim elements is also apparent from Figure 3B and Figure 13 of the ’667 Patent. Figure 3B “illustrates another embodiment of the pattern generation means: A segmented light source **135** [wherein] the individual LED segments **136** are turned on and off in a fashion to provide a known time-varying pattern on the object”:

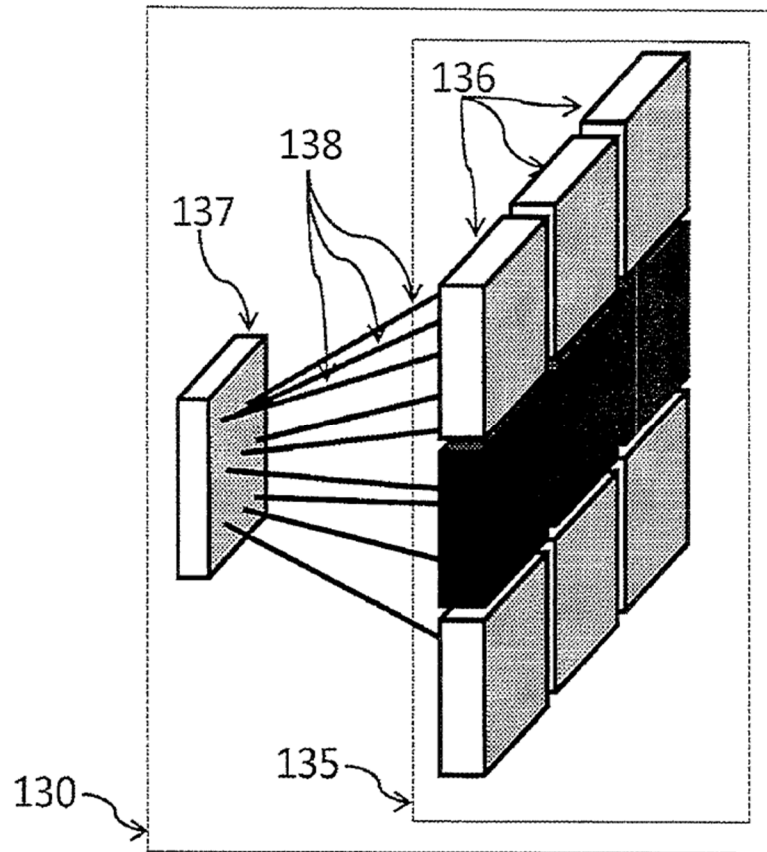
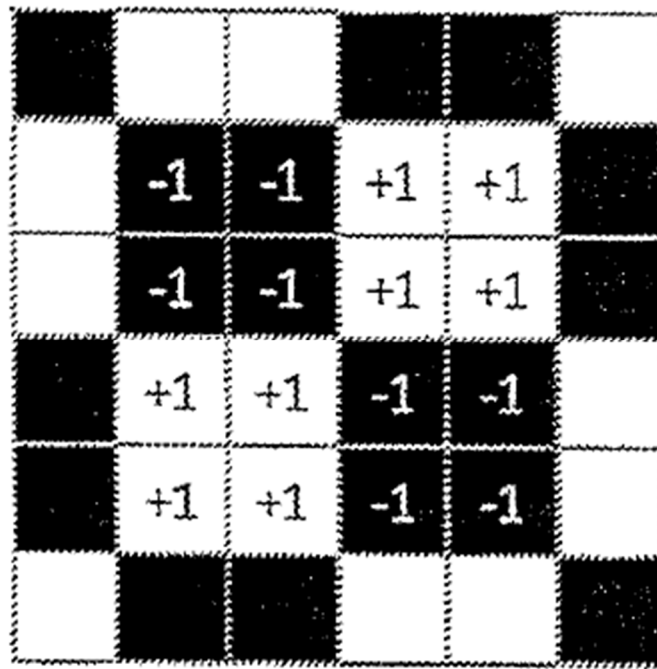


FIG. 3B of the '667 Patent

Id., 28:14-19. That is, the “probe light with a plurality of configurations” ***incorporates and provides*** a time-varying illumination pattern. *Id.*, 2:51-52 (“a probe light incorporating a spatial pattern”), 3:43-45 (“The probe light incorporating the pattern provides a pattern of light and darkness on the object.”), 8:12-14 (“Another central element of the disclosure is the probe light with an embedded pattern that is projected on to the object being scanned.”), 25:1.

Figure 13 provides a “schematic representation of the reference signal values/weights per pixel for a checkerboard pattern”:

**FIG. 13 of '667 Patent**

Id., 26:49-41. By varying the checkerboard pattern over time, a “time-varying illumination pattern” is provided. *Id.*, 8:12-16 (“Another central element of the disclosure is the probe light with an embedded pattern that is projected on to the object being scanned. The pattern may be static or time varying. The time varying pattern may provide a variation of light and darkness on and/or in the object.”). Thus, it is apparent in view of the specification of the '667 Patent that the recited “probe light with a plurality of configurations” and the recited “time-varying illumination pattern” are distinct claim elements.

Petitioner alleges that “probe light with a plurality of configurations” is satisfied with Zhang’s disclosure of an illumination pattern shifted across the

scene: “[t]he *plurality of configurations* are *the stripes being translated across the scene*.” See Pet. at 28 (emphasis in original). Similarly, Petitioner alleges that the claimed “time-varying illumination pattern” is satisfied by Zhang’s disclosure of an illumination pattern shifted across the scene: “The *illumination pattern* of Zhang that is *shifted across the scene* at time intervals, therefore, is a *time-varying illumination pattern*.” *Id.* (emphasis in original). Petitioner relies on the same illumination pattern/stripes shifted/translated across the scene disclosed by Zhang to satisfy both the “probe light with a plurality of configurations” and the “time-varying illumination pattern” claim elements. Petitioner and its expert make no assertion that the claimed “probe light with a plurality of configurations” and the claimed “time-varying illumination pattern” are somehow satisfied by distinct claim elements of Zhang’s system.

- ii. **It is impermissible for Petitioner to rely on the same “stripes being translated across the scene” disclosed by Zhang to somehow satisfy both the claimed “probe light with a plurality of configurations” and “time-varying illumination pattern” elements which are distinct from each other.**

It is impermissible for Petitioner to rely on the same “stripes being translated across the scene” disclosure of the Zhang system to satisfy both the claimed “probe light with a plurality of configurations” element and the claimed “time-varying illumination pattern” element which, as explained above, the claims and the

specification make clear are distinct claim elements. *See, e.g., Becton, Dickinson and Co. v. Tyco Healthcare Gr., LP*, 616 F.3d 1249, 1254 (Fed. Cir. 2010) (“Where a claim lists elements separately, ‘the clear implication of the claim language’ is that those elements are ‘distinct component[s]’ of the patented invention.”), quoting *Gaus v. Conair Corp.*, 363 F.3d 1284, 1288 (Fed. Cir. 2004); *see also Hopkins Mfg. Corp. v. Cequent Performance Products, Inc.*, IPR2015-00613, Paper 9 at 11-12 (PTAB Aug. 7, 2015) (rejecting petitioner’s argument that “a single structure may satisfy two limitations in a claim” and denying institution). This is particularly true when, as is the case with the ’667 Patent, the specification confirms that the claimed “probe light with a plurality of configurations” element and the claimed “time-varying illumination pattern” element are in fact distinct from each other. *See, e.g., Engel Indus., Inc. v. Lockformer Co.*, 96 F.3d 1398, 1404-05 (Fed. Cir. 1996) (concluding that where a claim provides for two separate elements, a “second portion” and a “return portion,” these two elements “logically cannot be one and the same”); *CAE Screenplates, Inc. v. Heinrich Fiedler GmbH & Co.*, 224 F.3d 1308, 1317 (Fed. Cir. 2000) (“In the absence of any evidence to the contrary, we must presume that the use of ... different terms in the claims connotes different meanings.”). Thus, even under Petitioner’s proposed construction for a “time-varying illumination pattern,” Petitioner has failed to

demonstrate that Zhang discloses both the claimed “probe light with a plurality of configurations” and the claimed “time-varying illumination pattern.”

iii. Petitioner fails to demonstrate that Zhang discloses a “probe light with a plurality of configurations” when properly construed.

Petitioner asserts that the “plurality of configurations” as recited in Claims 1, 14, and 26 “are the stripes being translated across the scene” in Zhang. Pet. at 28. However, Petitioner has overlooked the context of “plurality of configurations” as recited in Claims 1, 14, and 26.

Claims 1, 14, and 26 recite “a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern.” Because the illumination pattern is a light signal comprising an embedded spatial structure in the lateral plane, wherein the embedded spatial structure of the light signal varies in time, the probe light must have multiple configurations to vary that embedded spatial structure of the light signal over time. *See, e.g.*, EX1001, at Fig. 3B (illustrating a segmented light source 135, wherein the individual LED segments 136 are turned on and off in a fashion, *i.e.*, plurality of configurations, to focus a time-varying illumination pattern on the object).

Zhang, on the other hand, has a single configuration for its probe light. EX1006 at Figure 2(b) (depicting an illumination pattern that is shifted across the

scene) and 909, Section 3.3 (“[w]e have chosen to use a simple ... binary periodic sequence 011011011011... with period 3 [encoded] as a stripe pattern in which each bit corresponds to an 8-pixel wide stripe, as shown in Figure 2(b).”).

Thus, Zhang does not teach or suggest a “probe light with a plurality of configurations” as recited in Claims 1, 14, and 26 when properly construed. As such, the combination of Babayoff, Zhang, and Knighton also does not teach or suggest a “probe light with a plurality of configurations.” Accordingly, the combination of Babayoff, Zhang, and Knighton does not teach or suggest all of the claimed limitations of independent Claims 1, 14, and 26. For at least the same reasons, the combination of Babayoff, Zhang, and Knighton does not teach or suggest all of the claimed limitations of Claims 2-8, 13, 15-16, 18-22, and 28-29, which directly or indirectly depend from Claims 1, 14, and 26, respectively.

2. A POSA would not have been motivated modify Babayoff such that it incorporated the projection defocus system of Zhang.

There is no reason with rational underpinnings for replacing Babayoff’s intraoral scanner comprising a confocal optical system with Zhang’s projection defocus system. Petitioner’s reasons for modifying Babayoff with Zhang are undercut by Petitioner’s mischaracterization of Babayoff and the proposed modification itself.

Petitioner suggests replacing Babayoff’s confocal optical system with Zhang’s projection defocus system because “Zhang provides the *motivation* for using a *projection defocus method* with a shifting illumination pattern *as an alternative to a camera defocus method*.” Pet. at 29 (emphasis in original). In particular, Petitioner argues that Zhang’s projection defocus method provides “more accurate near depth discontinuities, is more simple, has lower computational complexity, is not subject to local minima, and is independent of scene geometry and texture, which makes it superior to camera defocus for depth estimation.” *Id.*; *see also* EX1002, ¶47. The premise upon which Petitioner bases its motivation argument is incorrect.

a. Babayoff does not disclose a camera defocus method.

Petitioner and its expert state that “Babayoff employs at least partially a *camera defocus method* for determining the depth coordinates.” Pet. at 27; EX1002, ¶66. As an initial matter, Petitioner and its expert are mistaken in identifying Babayoff’s optical system as employing a camera defocus method. Babayoff discloses a confocal focusing method. EX1005, [0010], [0028], [0040], [0073], [0134], [0137], [0142], [0149], [0151], [155]-[0156], [0158], [0166], [0168], [0170], [0172]-[0173], [0178], [0182], Claims 4, 34. Petitioner and Petitioner’s expert even admit as much in other sections of their respective pleadings. Pet. at 7; EX1002, ¶33. The term “defocus” is simply not recited in the

entirety of the Babayoff document. Further, none of the Babayoff citations that the Petitioner references (*e.g.*, EX1005, [0011], [0032], [0139]-[0142], FIGS. 4A, 8) discuss camera defocus methods. Pet. at 27; EX1002, ¶66.

Rather, they all refer to confocal optics or related techniques. For example, the step disclosed at paragraph [0011] is part of the “confocal focusing method” recited in paragraph [0010]. The translation mechanism at paragraph [0032] is part of the device that employs “confocal imaging techniques” at paragraph [0028]. Paragraphs [0139]-[0142] pertain to optical device 22 illustrated in FIG 4A. FIG 4A includes telecentric main confocal optics labeled as item 42. Further, paragraph [0142] specifically recites “telecentric confocal optics 42.” Finally, FIG 8 illustrates tri-color illumination being provided within the main focal optics 41, in particular at the confocal system aperture stop. EX1005, [0156].

Because Babayoff does not disclose or suggest a camera defocus method, Zhang’s “alternative to a camera defocus method” would not have motivated a POSA to modify Babayoff’s intraoral scanner with Zhang’s projection defocus system.

b. Zhang does not disclose a confocal focusing system.

Petitioner states that “Zhang is in the same field as Babayoff because Zhang also discloses a *confocal* or *coaxial* imaging system like Babayoff for obtaining 3D shape information of objects including teeth.” Pet. at 27. Petitioner’s expert

parrots the Petition. *Compare* first full paragraph at page 27 of Petition and ¶66 of EX1002. Here, both the Petitioner and its expert are factually incorrect.

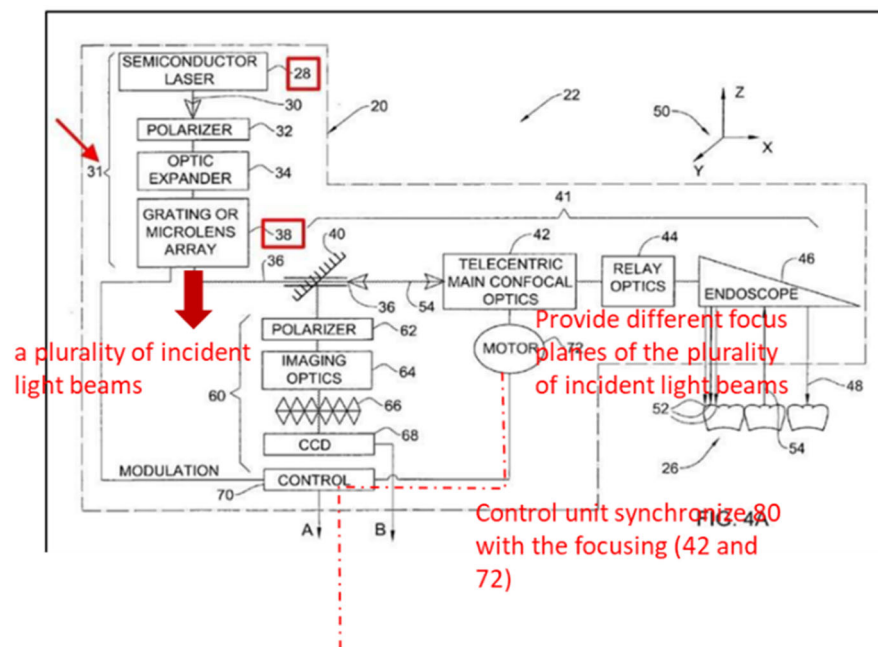
First, Zhang does not recite the term “confocal. EX1006. Second, Zhang does not characterize its imaging system as a confocal focusing system. Rather, Zhang consistently refers to its imaging system as a projection defocus system. *Id.* at Title, Abstract, Introduction, Section 3 (“Depth from Projection Defocus”), Section 4 (discussing minimizing defocus blur and defocus compensation algorithms), etc. Third, as discussed in more detail in Section V.A.2.c., Zhang does not describe or suggest optical or motor elements that are hallmarks of a confocal imaging system. Fourth, none of the citations to Zhang in the Petition or in Petitioner’s expert’s declaration demonstrate that “Zhang ... discloses a confocal ... imaging system like Babayoff.” Pages 907-910 of Zhang describe a projection defocus imaging system. Figure 1 of Zhang is labeled as providing “[t]he principle of depth from projection defocus.” Figure 2 of Zhang is labeled as illustrating “[a] coaxial projector-camera system for depth from projection defocus.” Figures 4 and 9 provide “[d]epth recovery results for three scenes” using projection defocus and “[r]esults for defocus compensation,” respectively.

Indeed, there are no underlying facts in support of the assertion that “Zhang ... discloses a confocal ... imaging system like Babayoff.” In such cases, the Director has been clear that institution should be denied when the expert

declaration presents conclusory assertions without underlying factual support and repeats verbatim the petitioner's argument. *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9 (PTAB Aug. 24, 2022), Paper 12 (PTAB Feb 10, 2023).

c. Petitioner's proposed combination would not replace Babayoff's depth measurement system with Zhang's projection defocus system.

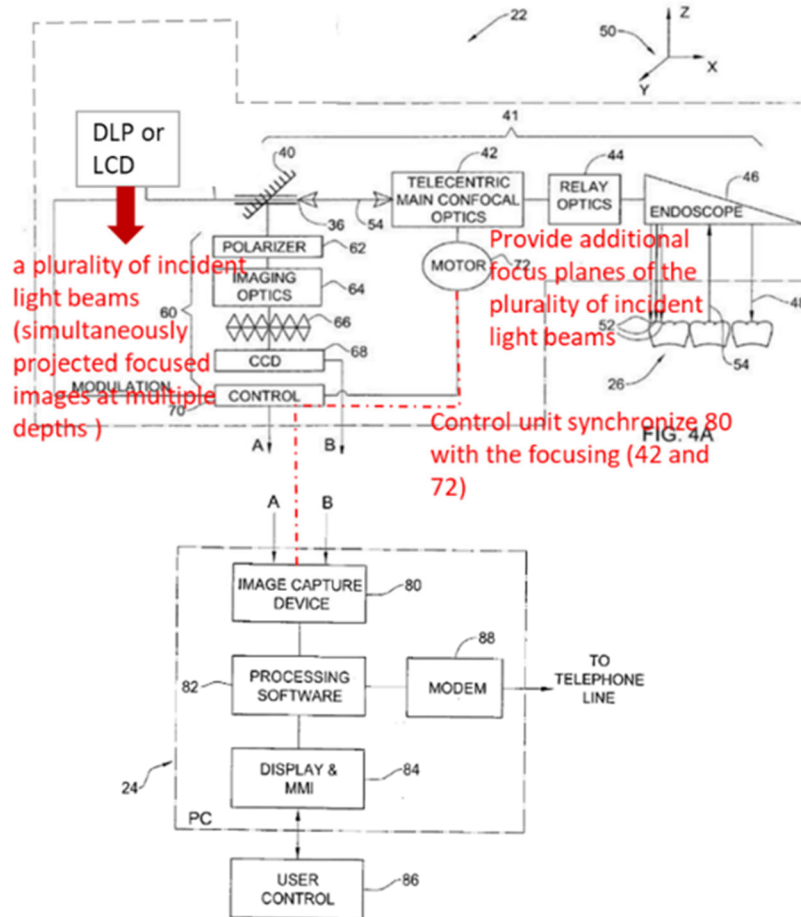
The basic confocal imaging principle involves using a spatial filter to limit the collected light from the object to a single plane, corresponding to the adjusted point of focus of the system. EX2006, at 32. Out-of-focus light is eliminated. EX1001, at 1:51-67. Multiple two-dimensional images at different depths (z direction) of a sample are captured to enable reconstruction of three-dimensional structures within an object. EX2006, at 32.



Modified and Annotated Version of Babayoff FIG. 4A

As discussed in the Petition and as illustrated above in a modified version of Babayoff's FIG. 4A, Babayoff provides motor 72 that displaces the confocal optical element 42 to change the focal plane location and then an image is captured by the image-capturing module 80 for the focal plane. Pet. at 26. Thus, the confocal optical and motor elements of Babayoff's intraoral scanner are critical for obtaining multiple two-dimensional images at different depths to enable three-dimensional reconstruction of a scanned object.

According to the Petitioner, Babayoff's intraoral scanner is modified by replacing its illumination source 31 with Zhang's DLP or LCD projector. *Id.* at 28. However, even if, *arguendo*, that Babayoff does disclose a camera defocus system (which it does not), the Petitioner does not advocate for replacing or modifying the confocal optics and motor of Babayoff—the crux of Babayoff's focusing method. Rather, the Petitioner relies on Babayoff's confocal optical system in its proposed combination as illustrated below in a further modified version of Babayoff's FIG. 4A and FIG. 4B.



2nd Modified and Annotated Version of Babayoff FIG. 4A and FIG. 4B

Further, Petitioner relies on Babayoff as follows:

The probe light, therefore, is transmitted through the *tip* of the intraoral scanner, such as part of the *endoscope 46* that can be in the form of a *probing member 90*. The probe light is transmitted toward the object 26 along an optical path, which includes at least part of the *main optics 41*, such as the *confocal optics 42* and the *relay optics 44*. By having the illumination source 31 of Babayoff replaced by the projector of Zhang to provide the probe light with the time-varying illumination

pattern, at least part of the object 26 in Babayoff would thereby be illuminated with the time-varying illumination pattern.

Id., at 33 (emphasis in original). Because Babayoff’s focusing elements and methods are not replaced by the mere modification of its illumination source 31, a POSA would not have understood Petitioner’s combination to “determine depth using the ***projection defocus method*** of Zhang rather than the method of Babayoff [emphasis in original]” as asserted by the Petitioner. *Id.*, at 28. Thus, a POSA would not have had the requisite motivation to modify Babayoff’s intraoral scanner with only Zhang’s DLP or LCD projector because doing so would not replace the focusing method of Babayoff with the projection defocus method of Zhang.¹

To recap, Petitioner stated that “Zhang provides the ***motivation*** for using a ***projection defocus method*** with a shifting illumination pattern ***as an alternative to a camera defocus method.***” *Id.*, at 29 (emphasis in original). However, a POSA would not have been motivated to modify Babayoff with Zhang as proposed by the Petitioner. This is because (1) Babayoff does not disclose a camera defocus

¹Petitioner does not advocate for a combination that comprises both (i) a camera defocus system ***and*** a projection defocus system or (ii) a camera defocus system ***and*** a confocal imaging system.

imaging system; (2) Zhang does not disclose a confocal imaging system; (3) Zhang's projection defocus imaging system is not at all like Babayoff's confocal imaging system; (4) Zhang does not disclose or suggest replacing Babayoff's confocal imaging system with Zhang's projection defocus imaging system; and (5) the Petitioner's proposed combination device does not replace or remove the confocal optics of Babayoff's imaging system and, therefore, does not replace Babayoff's confocal imaging system with Zhang's projection defocus system. In summary, Petitioner's motivation rationale is undercut by the structural features of Petitioner's proposed combination device and the very disclosures cited and relied on by the Petitioner.

3. Petitioner's combination would not have provided a POSA with a reasonable expectation of successfully arriving at the claimed invention.

Petitioner alleges that “[a] POSA would have expected such a combination to work for its intended purpose because Zhang already applied the time-varying illumination pattern technique to structures that are on the same scale as parts of teeth, including toys with teeth, so it would be expected to work for imaging teeth.” *Id.*, at 29. Petitioner also alleges that “the modification to the Babayoff device to include a DLP or LCD projector as taught by Zhang in place of the illumination source 31 would have been straightforward for a POSA to implement because it is

just the substitution of one known element for another.” *Id.* Petitioner is incorrect in all of its allegations.

a. Zhang’s projection defocus system is not suitable for intraoral applications.

Claims 1, 14, and 26 recite “[a] handheld intraoral scanner for determining the 3D geometry and color of at least a part of the surface of an object in an oral cavity.” As discussed in Section IV.D., “the object” recited in Claims 1, 14, and 26 refers to an object in an oral cavity. Objects in the oral cavity, such as teeth, exist on the order of millimeters. EX2007, Table 1. Thus, the intraoral scanners of Claims 1, 14, and 26 would need to distinguish structures on the order of millimeters.

Zhang discloses that its “depth estimation noise is from 4mm for a working volume of 600mm.” EX1006 at 911. That is, Zhang’s depth estimation noise is on the same order as the length of teeth within an oral cavity. With such large noise, Zhang’s projection defocus method is not suitable for determining the 3D geometry and color of objects in an oral cavity.

b. Zhang does not determine the 3D geometry and color of toy teeth, much less the teeth found in an oral cavity.

While the Petitioner suggests that “Zhang already applied the time-varying illumination pattern to structures that are on the same scale as parts of teeth, including toys with *teeth*,” it is important to note that there is no recitation of

“teeth” or “tooth” in Zhang. Pet. at 30. Further, the depth recovery results provided by Zhang as gray-shaded 3D-models of the scene (*e.g.*, Figure 4) are of such poor resolution that the teeth of the toy figures are not discernible. For at least this reason, Petitioner is incorrect in asserting that “Zhang already applied the time-varying illumination pattern technique to structures that are on the same scale as parts of teeth.” *Id.*

c. Modifying Babayoff’s device to include Zhang’s DLP or LCD projector would not have been straightforward for a POSA.

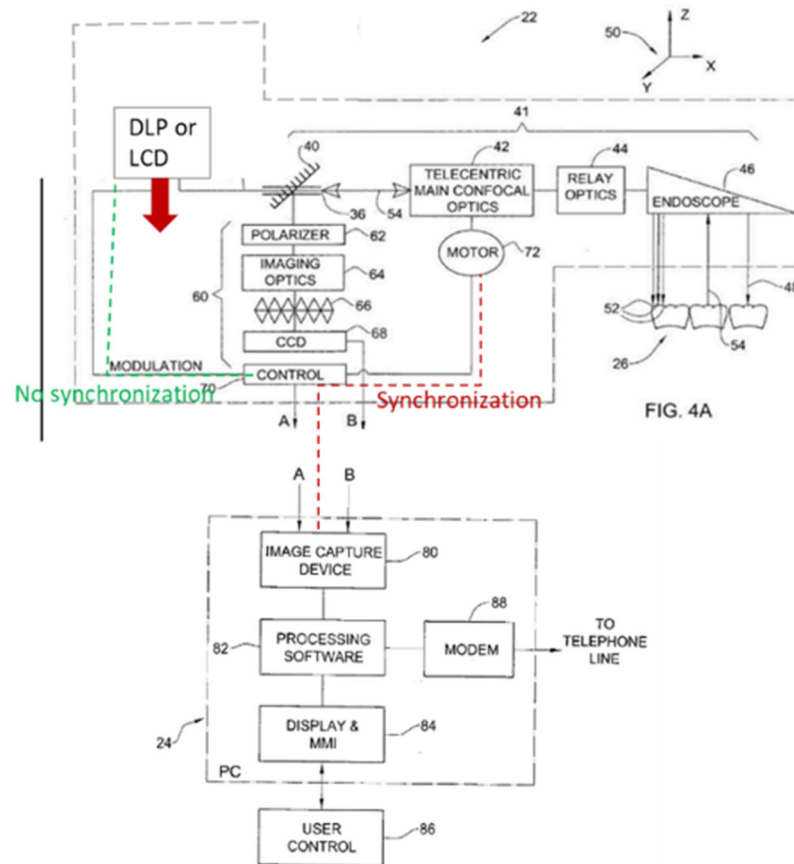
Modifying Babayoff’s device to include Zhang’s DLP or LCD projector *and* successfully arriving at the claimed invention would have been difficult for a POSA because Zhang’s disclosures undercut any “straightforward” techniques.

For example, Zhang’s projection defocus method relies on a single projector. EX1006, Section 3.3 (“an NEC LT260K DLP projector”), 907, 908 (“In our case, we use a single projector to simultaneously project well-focused images at multiple depths.”), 911 (“Our method requires just a camera and can be applied to any off-the-shelf projector.”). However, “[d]ue to their optical design, standard projectors can only be focused on a single fronto-parallel plane.” *Id.* at 911. While Zhang recognizes that “it is desirable to project images onto non-planar structures,” like teeth, Zhang notes that “[i]n such cases most parts of the image are blurred due to defocus.” *Id.* Zhang hypothesizes that “[o]ne way to solve this problem is to

design sophisticated optics.” *Id.* However, neither Zhang nor the Petitioner describe or discuss such sophisticated optics that could employ the single projector of Zhang in Babayoff’s intraoral scanner to project images onto non-planar structures, much less successfully determine the 3D geometry and color of at least a part of the surface of an object in an oral cavity. Moreover, Zhang declares that “[e]ven if this is possible, the optics cannot be modified to accommodate changes in the structure that is being projected onto.” *Id.* Thus, the replacement of Babayoff’s illumination source 31 with Zhang’s DLP or LCD projector would neither have been straightforward to a POSA nor would have provided a POSA with a reasonable expectation of successfully arriving at the claimed invention.

Petitioner suggests that “the ’667 Patent itself is written with the understanding that a POSA would understand how to include an LCD or DLP projector in a hand-held scanning device.” Pet. at 30. While a POSA would have understood how to include an LCD or DLP projector in a hand-held intraoral scanning device, that does not mean that a POSA would have known how, or would have been motivated, to modify *Babayoff’s intraoral scanner* to include *Zhang’s projector* so as to project images onto non-planar structures or multiple planes. If it was Petitioner’s intent to rely on the confocal optics of Babayoff to focus images at multiple planes, neither the Petitioner nor its expert discuss how to synchronize a single projector with the controllable motorized optics of Babayoff

to change focal plane location. Taken one step further, neither the Petitioner nor its expert discuss how to synchronize a single projector with the controllable motorized optics of Babayoff and the image-capturing module of Babayoff as illustrated below in a further modified version of Babayoff's FIG. 4A and FIG. 4B.



3rd Modified and Annotated Version of Babayoff FIG. 4A and FIG. 4B

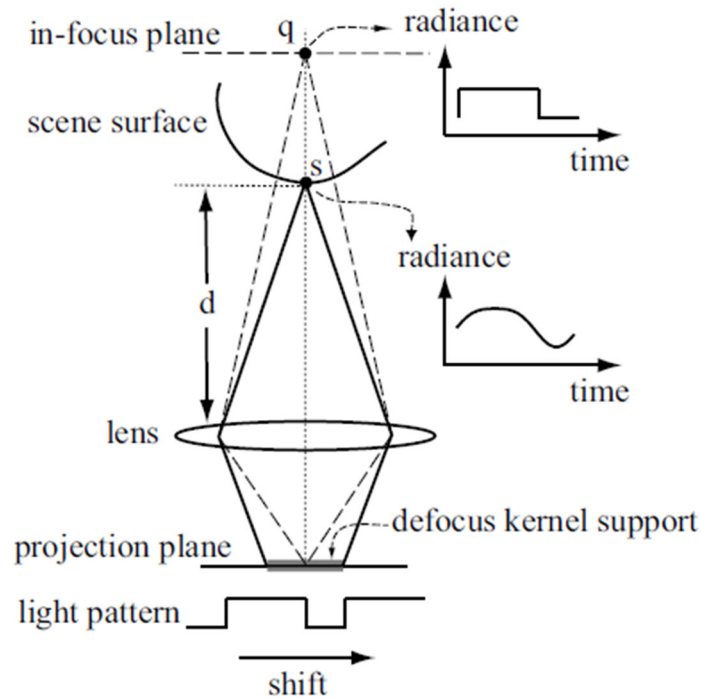
While Zhang does discuss “a computational method that processes an input image in a scene-dependent way to minimize the blur at all points in the projected output image” to focus projection on multiple planes, this algorithmic method belies the purported advantage of projection defocus methods having lower

computational complexity. EX1006 at 907, 911, Focused Projection at Multiple Depths. In any event, neither Petitioner nor its expert discuss employing these complex computational methods in Babayoff's intraoral scanner modified with Zhang's DLP or LCD projector.

Thus, for all of the foregoing reasons, a POSA would not have had a reasonable expectation of successfully arriving at the claimed invention by modifying Babayoff's device to include Zhang's DLP or LCD projector.

d. Zhang's projection defocus method differs substantially from Babayoff's focusing method, rendering it unsuitable for combination with Babayoff and use in intraoral applications.

The projection defocus system of Zhang uses "temporal blur for depth recovery." EX1006 at 909. This temporal blur is obtained at scanned object points that are at different distances to the z direction fixed-position projector. *Id.*; see also Figure 1 of Zhang:



As compared to Babayoff's confocal focusing method, the temporal/projector defocus method of Zhang always relies on out-of-focus irradiance (*e.g.*, obtained from point s above). *Id.* at 909 ("The projector is always focused on a plane behind the working volume to avoid a two-way defocus ambiguity."). Because the focal plane is always behind the scene surface, any intraoral scanner that relied on Zhang's methods would result in blurry proximal images, *e.g.*, front teeth would be blurred in an intraoral scan.

Further, as compared to the confocal focusing method of Babayoff which allows for movement in the z direction, Zhang's projector defocus method is limited to projecting the stripe pattern in just the x (horizontal) and y (vertical) directions. *Id.*; *see also id.* at 911 (proposing a computational method to minimize

defocus blur instead of allowing for focusing on multiple fronto-parallel planes). Zhang's projection defocus method appears to work well with static scenes, such as the white board with four markers tiled in front of the camera (Figure 3), the book and block scene (Figure 4), toy figures scene (Figure 4), and poinsettia behind fence scene (Figure 4). However, Zhang admits that its method is incapable of capturing a dynamic scene because it uses 24 images for depth estimation—too many for a real-time sensor that can handle dynamic scenes. *Id.* at 909, 910, 915. Despite theorizing that the number of images used for depth estimation could be reduced, Zhang also admits even worse effects associated with its projector:

In our experiments, we have found that the projector produces several undesirable effects: it vibrates at a high frequency, possibly due to the rotation of its fan; its brightness is not stable over time; *the imprecise synchronization between the camera and projector* causes measured radiances to fluctuate slightly over time. To resolve these issues, *we repeat the shifting of the pattern about 85 times and compute a mean image for each shift.* The camera runs at 60Hz and the total acquisition time is within a minute.

Id., fn5. That is, Zhang discloses (i) problematic synchronization issues between its own projector and camera, (ii) even more images used for depth estimation to alleviate the above-listed undesirable effects, and (iii) an acquisition time of about

a minute. Neither the Petitioner nor its expert discuss how to address Zhang's problematic synchronization issues prior to the incorporation of Zhang's DLP or PLD projector into Babayoff's intraoral scanner. These issues would only be further exacerbated in the proposed combination as neither the Petitioner nor its expert discuss (i) how to synchronize a single projector with the controllable motorized optics of Babayoff to change focal plane location, or (ii) how to synchronize a single projector with the controllable motorized optics of Babayoff and the image-capturing module of Babayoff. And, even when Zhang uses computational methods to provide focused projection at multiple depths, Zhang's projection defocus method is still subject to projector artifacts. *Id.* at 912, fn9 ("We found that even if we focus a projector on a fronto-parallel plane, when projecting a binary dot pattern, we see 'light leakage' from one pixel into its neighbors.").

Furthermore, Zhang's projection defocus method relies on a lookup table generated from deconvoluting the observed irradiance. *Id.* at 908, Eq. (1) and 910. Zhang's lookup table is based on "calibrat[ing] the mapping from the θ in Eq. (3) to the depth z ." *Id.* at 909. However, this calibration method is not suitable for dynamic scene scanning (*i.e.*, intraoral scanning) as it is generated from static scenes with no movement of the projector in the z direction.

Finally, Zhang admits that “[o]ne challenging open problem for defocus-based methods is handling translucent objects.” *Id.* at 915. In particular, Zhang notes that “[a] translucent material introduces additional blur due to subsurface scattering, which would cause a systematic bias in our methods.” *Id.* If the defocus blur is dominated by the transparency blur, the error will be large. *Id.* As the crown of a tooth is the part that emerges from the maxillary or jaw bone and has a hard and translucent surface (enamel), it is imperative that an intraoral scanner be able to determine the 3D geometry and color of this structure because this is the portion of the tooth that is exposed and available for depth estimation. EX2008, at 6. Because Zhang’s projection defocus method has difficulties with translucent objects, Zhang’s projection defocus method is not suitable for intraoral scanning.

For all of the reasons provided above, Zhang’s projection defocus method (i) differs substantially from Babayoff’s focusing method and, (ii) renders it unsuitable for intraoral scanning. Accordingly, a POSA would not have had a reasonable expectation of successfully arriving at the claimed invention by combining Babayoff and Zhang as proposed by the Petitioner.

B. Petitioner fails to demonstrate that the Petitioner would prevail with respect to at least one of the claims challenged in Ground 2

For the same reasons provided above with respect to Ground 1, Petitioner fails to demonstrate a reasonable likelihood of prevailing with respect to Ground 2.

1. None of the asserted references, either alone or in combination, disclose or suggest each and every limitation of the challenged claims.

As discussed in further detail below, Petitioner fails to demonstrate that the cited references, either alone or in combination, disclose or suggest each and every limitation of the challenged claims. In particular, Petitioner has failed to demonstrate that the cited references, either alone or in combination, disclose or suggest the following claim limitations: (i) a “time-varying illumination pattern,” and (ii) “a probe light with a plurality of configurations.

a. None of the asserted references disclose a “time-varying illumination pattern.”

Claims 1, 14, and 26 (from which Claims 12, 17, and 27 depend) recite a “time-varying illumination pattern.” As admitted in the Petition, “Babayoff does not explicitly disclose that the light pattern is time-varying.” Pet. at 27, 68. Petitioner also provides no evidence or arguments to infer that Babayoff implicitly discloses that its purported light pattern is time-varying.

In an attempt to address Babayoff’s deficiency, Petitioner asserts that “[t]he illumination pattern of Zhang that is shifted across the scene at time intervals ... is a time-varying illumination pattern.” *Id.* at 28, 68. The Petition does not allege that Knighton or Serra disclose or suggest a “time-varying illumination pattern.” For the same reasons provided above in Section V.A.1.a., the combination of

Babayoff, Zhang, Knighton, and Serra does not teach or suggest all of the claimed limitations of dependent Claims 12, 17, and 27.

b. Petitioner impermissibly relies on the same Zhang disclosure to allegedly satisfy two distinct elements recited in the claims.

In the claims of the '667 Patent, the recited “probe light with a plurality of configurations” is a distinct claim element from the recited “time-varying illumination.” For the reasons discussed below, it is impermissible for Petitioner to rely on the same “stripe pattern that is shifted across the scene” disclosed by Zhang to somehow satisfy both the claimed “probe light with a plurality of configurations” and “time-varying illumination” elements.

i. The claimed “probe light with a plurality of configurations” is a distinct element from the claimed “time-varying illumination pattern.”

Claims 1, 14, and 26 (from which Claims 12, 17, and 27 depend) recite “a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern.” EX1001, 37:33-35, 38:53-55, 40:7-9. As discussed above, the illumination pattern is an embedded spatial structure of the light signal that varies with time. The probe light has “a plurality of configurations” and is transmitted “towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern.” *Id.* That is, the probe light is used to illuminate at

least part of the object being scanned with the time-varying illumination pattern. Thus, neither the probe light nor the plurality of configurations of the probe light are the time-varying illumination pattern itself. This is apparent from the plain language of the claim.

That the recited “probe light with a plurality of configurations” and the recited “time-varying illumination pattern” are distinct claim elements is also apparent from Figure 3B and Figure 13 of the ’667 Patent. *See* § V.A.1.d.

Petitioner relies on the same illumination pattern/stripes shifted/translated across the scene disclosed by Zhang to satisfy both the “probe light with a plurality of configurations” and the “time-varying illumination pattern” claim elements. Petitioner and its expert make no assertion that the claimed “probe light with a plurality of configurations” and the claimed “time-varying illumination pattern” are somehow satisfied by distinct claim elements of Zhang’s system.

- ii. **It is impermissible for Petitioner to rely on the same “stripes being translated across the scene” disclosed by Zhang to somehow satisfy both the claimed “probe light with a plurality of configurations” and “time-varying illumination pattern” elements which are distinct from each other.**

It is impermissible for Petitioner to rely on the same “stripes being translated across the scene” disclosure of the Zhang system to satisfy both the claimed “probe light with a plurality of configurations” element and the claimed “time-varying

illumination pattern” element which, as explained above, the claims and the specification make clear are distinct claim elements. *See, e.g., Becton, Dickinson and Co.*, 616 F.3d at 1254; *see also Hopkins Mfg. Corp.*, IPR2015-00613, Paper 9 at 11-12. This is particularly true when, as is the case with the ’667 Patent, the specification confirms that the claimed “probe light with a plurality of configurations” element and the claimed “time-varying illumination pattern” element are in fact distinct from each other. *See, e.g., Engel Indus., Inc.*, 96 F.3d at 1404-05; *CAE Screenplates, Inc.*, 224 at 1317. Thus, even under Petitioner’s proposed construction for a “time-varying illumination pattern,” Petitioner has failed to demonstrate that Zhang discloses both the claimed “probe light with a plurality of configurations” and the claimed “time-varying illumination pattern.”

iii. Petitioner fails to demonstrate that Zhang discloses a “probe light with a plurality of configurations” when properly construed.

Claims 1, 14, and 26 (from which Claims 12, 17, and 27 depend) recite “a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern.” Because the illumination pattern is a light signal comprising an embedded spatial structure in the lateral plane, wherein the embedded spatial structure of the light signal varies in time, the probe light must have multiple configurations to vary that embedded spatial structure of the light signal over time. *See, e.g., EX1001 at Fig*

3B (illustrating a segmented light source 135, wherein the individual LED segments 136 are turned on and off in a fashion, *i.e.*, plurality of configurations, to focus a time-varying illumination pattern on the object).

Zhang, on the other hand, has a single configuration for its probe light. EX1006 at Figure 2(b) (depicting an illumination pattern that is shifted across the scene) and 909, Section 3.3 (“[w]e have chosen to use a simple ... binary periodic sequence 011011011011... with period 3 [encoded] as a stripe pattern in which each bit corresponds to an 8-pixel wide stripe, as shown in Figure 2(b).”).

Thus, Zhang does not teach or suggest a “probe light with a plurality of configurations” as recited in Claims 1, 14, and 26, when properly construed. As such, the combination of Babayoff, Zhang, Knighton, and Serra also does not teach or suggest a “probe light with a plurality of configurations.” Accordingly, the combination of Babayoff, Zhang, Knighton, and Serra does not teach or suggest all of the claimed limitations of dependent Claims 12, 17, and 27.

2. A POSA would not have been motivated to modify Babayoff such that it incorporated the projection defocus system of Zhang.

There is no reason with rational underpinnings for replacing Babayoff’s intraoral scanner comprising a confocal optical system with Zhang’s projection defocus system. Petitioner’s reasons for modifying Babayoff with Zhang are

undercut by Petitioner's mischaracterization of Babayoff and the proposed modification itself as discussed with respect to Ground 1 in Section V.A.2. above.

3. Petitioner's combination would not have provided a POSA with a reasonable expectation of successfully arriving at the claimed invention.

For the same reasons provided above with respect to Ground 1, Petitioner's proposed combination would not have provided a POSA with a reasonable expectation of successfully arriving at the claimed invention. *See* § V.A.3. above.

Further, Claims 1, 14, and 26 (from which Claims 12, 17, and 27 depend) recite “[a]n intraoral scanner for determining the 3D geometry and color of at least a part of the surface of an object in an oral cavity.” As discussed in Section IV.D., “the object” recited in Claims 1, 14, and 26 refers to an object in an oral cavity. Objects in the oral cavity, such as teeth, exist on the order of millimeters. EX2007, Table 1. Thus, the intraoral scanners of Claims 1, 14, and 26 would need to distinguish structures on the order of millimeters.

Zhang discloses that its “depth estimation noise is from 4mm for a working volume of 600mm.” EX1006, at 911. That is, Zhang's depth estimation noise is on the same order as the length of teeth within an oral cavity. With such large noise, Zhang's projection defocus method is not suitable for determining the 3D geometry and color of objects in an oral cavity.

C. Discretionary Denial of Institution

Petitioner fails to demonstrate a reasonable likelihood of success with respect to all of the grounds in the Petition. *See* §V. Thus, this Petition should be denied. In the event the Board determines that Petitioner has satisfied its burden with respect to some but not all grounds, this Petition nevertheless should be denied given the inefficiencies associated with conducting trial on grounds and claims for which Petitioner has failed to satisfy its burden. *See, e.g., Deeper UAB v. Vexilar, Inc.*, IPR2018-01310, Paper 7 (PTAB Jan. 24, 2019); *Chevron Oronite Co. LLC v. Infineum USA LP*, IPR2018-00923, Paper 9 (PTAB Nov. 7, 2018).

Denial is appropriate here based on the two-step framework articulated in *Advanced Bionics, LLC v. Med-El Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 7-8 (PTAB Feb. 13, 2020). The first *Advanced Bionics* step is satisfied because the Petition relies on substantially the same prior art and arguments that were previously considered by the Office during prosecution.

Petitioner fails to disclose that U.S. 2005/0283065 (related to the asserted Babayoff reference) was used to map the elements of the claimed invention in almost the same manner during prosecution of ancestral U.S. Patent No. 10,326,982 as Petitioner does here with Babayoff. *See* Office Action of February 7, 2019 of U.S. Patent No. 10,326,982 file history, EX2001.

Claim	Limitation	U.S. 2005/0283065 (EX2012) EX2001 at 3-4 [emphasis in original]	Babayoff Citation in Petition
1[pre]	An intraoral scanner for determining the 3D geometry and color of at least a part of the surface of an object in an oral cavity, the intraoral scanner comprising:	“Babayoff discloses a scanner for determining the 3D geometry and color of at least a part of the surface of an object, scanner comprising: at least one camera accommodating an array of sensor elements (see fig. 1 ¶s 107, 118 for at least one camera (i.e. CCD camera 68 as shown in fig. 4A) accommodating an array of sensor elements (i.e. array of sensing elements)),”	Fig. 1 (ref 100), Fig. 4A, 8, Abstract, [0001], [0009], [0128]-[0149], [0179]
1[a]	a tip configured to be inserted into the oral cavity;		Figs. 1, 4A, 8 are identical between U.S. 2005/0283065 and Babayoff.
1[b]	at least one camera accommodating an array of sensor elements;		Fig. 4A (ref. 46), 5C, [0137], [0146]
1[c]	a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern;	“a light source for generating a probe light (see ¶ 116 for a light source (i.e. endoscope 46 as shown in fig. 4A) for generating a probe light)” “Babayoff fails to explicitly teach wherein the plurality of configurations is in the	Fig. 1, 8 Fig. 4A (ref. 38), [0030], [0134], [0135], [0139], [0156]-[0157]

Claim	Limitation	U.S. 2005/0283065 (EX2012) EX2001 at 3-4 [emphasis in original]	Babayoff Citation in Petition
		form of a time-varying illumination pattern, such that the 3D geometry is determined based on the time-varying illumination pattern.”	
1[d]	an optical system configured to transmit the probe light towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;	“an optical system for transmitting the probe light towards the object along an optical path thereby illuminating at least a part of the object in a plurality of configurations (see ¶ 116 for an optical system (i.e. optical device 22 as shown in fig. 4A) for transmitting the probe light towards the object in a plurality of configurations (i.e. the endoscope 46 thus emits a plurality of incident light beams 48 impinging on to the surface of the teeth section as shown in fig. 4A)) and for transmitting at least a part of the light returned from the object to the at least one camera (see ¶ 118 for transmitting at least a part of the light returned from the object to the at least one camera (i.e. the returned light beams are reflected in the direction of the detection	Fig. 1, 4A, 5C, 8, [0002], [0011], [0033], [0042], [0129], [0134]

Claim	Limitation	U.S. 2005/0283065 (EX2012) EX2001 at 3-4 [emphasis in original]	Babayoff Citation in Petition
		optics 60 which includes the CCD camera 68 as shown in fig. 4A))”	
1[e]	one or more motion sensors located on the intraoral scanner to measure three-dimensional motion of the intraoral scanner, wherein the intraoral scanner is wireless; and		
1[f]	a hardware processor configured to:	“a hardware processor configured to:	Fig. 1, 5A, 5C, 8, 9,
1[f][1]	selectively switch a color of the probe light, thereby illuminating the object with different colors at different times; and	selectively switch a color of the probe light, thereby illuminating the object with different colors at different times, record different images by the at	[0044], [0063], [0064], [0079], [0130], [0131], [0145]-[0151], [0155]-[0157]
1[f][2]	record images of the object with the different colors by recording different images by the at least one camera at the different times.	least one camera at the different times, thereby recording images of the object with the different colors, and combine the different colors from the different images, thereby obtaining the color of the surface of the object (see ¶ 108 for a hardware processor (i.e. processor 24 as shown in fig. 4B) configured to: selectively switch a color of the probe light, thereby illuminating the object with different colors at	Fig. 1, 4A, 8, [0044]-[0045], [0079], [0092], [0130], [0145]

Claim	Limitation	U.S. 2005/0283065 (EX2012) EX2001 at 3-4 [emphasis in original]	Babayoff Citation in Petition
		different times, record different images by the at least one camera at the different times, thereby recording images of the object with the different colors, and combine the different colors from the different images, thereby obtaining the color of the surface of the object (i.e. selectively illuminating the object 26 with suitable colors, typically Green, Red and Blue, and for each such monochromatic illumination, a two dimensional image of the object 26 is captured by the detection optics 60, and the processor 24 then processes the three differently colored monochromatic images and combines the same to provide a full color 2D image of the object.) Thus it would have [sic] obvious to one of ordinary skills in the art to use a buffer to record different images captured by the detection topics 60 at the different times, thereby recording images	

Claim	Limitation	U.S. 2005/0283065 (EX2012) EX2001 at 3-4 [emphasis in original]	Babayoff Citation in Petition
		of the object 26 with the different colors)”	

Even with regard to claim elements 1[a], U.S. Publ. No. 2005/0283065 provides disclosures similar to those of Babayoff. For example, *see* EX2012, at Figs. 1 and 4A and ¶¶[0115] and [0124] for an endoscope tip configured to be inserted into the oral cavity.

Further, Petitioner relies on Zhang to cure the deficiencies of Babayoff much like the Examiner relied on Heinz to cure the deficiencies of U.S. Publ. No. 2005/0283065. *See* EX2001 at 5 (“However, the reference Heinz explicitly teaches wherein the plurality of configurations is in the form of a time-varying illumination pattern, such that the 3D geometry is determined based on the time-varying illumination pattern (see fig. 3 ¶ 66 for the plurality of configurations is in the form of a time-varying illumination pattern, such that the 3D geometry is determined based on the time-varying illumination pattern (i.e. the multimode interference pattern that illuminates detector 805 is time-varying in accordance with the movement of surface 804 (or end 814 or d)) as described in fig. 8 paragraph 69) [emphasis in original].”

Furthermore, Zhang and Heinz both fail to cure the deficiencies of Babayoff and U.S. Publ. No. 2005/0283065, respectively, for the exact same reason: both references disclose moving an illumination pattern across an object being scanned, an embodiment not encompassed by the claim term “time-varying illumination pattern.” Thus, Petition relies on substantially the same prior art and arguments that were previously considered by the Office during prosecution.

In any event, Petitioner has not met its burden to show that the Examiner erred because the Petition does not discuss the prosecution history of the '146 Patent family at any depth beyond cursorily summarizing the '146 Patent prosecution history.

VI. CONCLUSION

Petitioner fails to demonstrate that any of the challenged claims of the '667 Patent are unpatentable. Thus, the Petition should be denied.

Respectfully submitted,

Date: April 10, 2023

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APPENDIX A - LIST OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 11,368,667 (“the ’667 patent”)
1002	Declaration of Dr. Mohit Gupta (“Gupta Decl.”)
1005	U.S. Patent App. Pub. No. 2008/0024768 to Noam Babayoff (“Babayoff”)
1006	L. Zhang et al., “Projection Defocus Analysis for Scene Capture and Image Display,” ACM SIGGRAPH 2006, July 2006, pp. 907-915 (“Zhang”)
2001	Office Action dated February 7, 2019 in U.S. Patent Application No. 16/217,943
2002	Interview Summary filed on March 12, 2019 in U.S. Patent Application No. 16/217,943
2003	Notice of Allowance dated March 20, 2019 in U.S. Patent Application No. 16/217,943
2004	U.S. Patent Application Publication No. 2007/0041729 published on February 22, 2007 (“Heinz”)
2005	Joint Claim Construction Chart filed on December 2, 2022, 3Shape’s Opening Brief on Claim Construction filed on January 30, 2023, and 3Shape’s Responsive Brief on Claim Construction filed on February 16, 2023 in <i>3Shape A/S v. Carestream Dental, LLC et al.</i> , Civ. Action No. 22-cv-01829 (NDGA)
2006	A. Constans, <i>The Confocal Microscope</i> , 18(22) THE SCIENTIST 32-33 (2004)
2007	M.S. Beni et al., <i>Dispersion of OH Radicals in Applications Related to Fear-Free Dentistry Using Cold Plasma</i> , 9 APPL. SCI. 1-13 (2019)

Exhibit	Description
2008	F. Farci and A. Soni, <i>Histology, Tooth</i> in StatPearls (updated July 2022), available at https://www.ncbi.nlm.nih.gov/books/NBK572055/
2009	Not yet assigned
2010	Not yet assigned
2011	Not yet assigned
2012	U.S. Patent Application Publication No. 2005/0283065, published on December 22, 2005 to N. Babayoff

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

I hereby certify that the word count for the foregoing Patent Owner's Preliminary Response totals 13,086 words, excluding the parts which are exempted by 37 C.F.R. § 42.24(a).

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing **PATENT OWNER'S PRELIMINARY RESPONSE** is being served on counsel for Petitioner by electronic mail this 10th day of April, 2023 as follows:

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