

IPR2023-01317
Patent No. 11,368,667

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MEDIT CORPORATION,

Petitioner,

v.

3SHAPE A/S,

Patent Owner.

Case No.: IPR2023-01317
U.S. Patent No. 11,368,667

**PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 11,368,667**

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1001	U.S. Patent No. 11,368,667
1002	Excerpts of the File History for U.S. Patent No. 11,368,667
1003	U.S. Patent No. 6,008,905 (“Breton”)
1004	U.S. Patent No. 7,336,375 (“Faul”)
1005	WIPO Publication No. 01/84479 A1 (“Orametrix”)
1006	Claim Construction Order, <i>3Shape A/S v. Medit Corporation</i> , Case No. 6:22-cv-00443, Dkt. No. 76 (W.D. Tex. May 2, 2023)
1007	R.J. Valkenburg, A.M. McIvor, “Accurate 3D measurement using a structured light system”, <i>Image and Vision Computing</i> (1998) (“Valkenburg”)
1008	U.S. Publication No. 2005/0237581 (“Knighton”)
1009	Curriculum Vitae of Dr. Rongguang Liang
1010	U.S. Patent Application Publication No. 2008/0118143 (“Gordon”)
1011	Nathan S. Birnbaum, et al. “3D Digital Scanners: A High Tech Approach to More Accurate Dental Impressions”, <i>Inside Dentistry</i> (April 2009) (“Birnbaum”)
1012	U.S. Patent No. 11,076,146
1013	Expert Declaration of Dr. Rongguang Liang

Challenged Claims of U.S. Patent No. 11,368,667

Claim element	Claim 1
[Claim 1 pre]	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:
[Claim 1a]	a tip configured to be inserted into the oral cavity;
[Claim 1b]	at least one camera accommodating an array of sensor elements;
[Claim 1c]	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;
[Claim 1d]	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 . . .
[Claim 1e]	an optical system configured 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
[Claim 1f]	wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;
[Claim 1g]	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
[Claim 1h]	a hardware processor, located within the wireless intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; and
[Claim 1i]	a hardware processor, located within the wireless intraoral scanner, configured to: ... record images of the object with the different colors by recording different images by the at least one camera at the different times.

Claim element	Claim 2
[Claim 2]	The handheld intraoral scanner according to claim 1, wherein the light source further comprises at least three monochromatic light sources configured to provide the different colors.
Claim element	Claim 3
[Claim 3]	The handheld intraoral scanner according to claim 2, wherein for the selectively switch the color of the probe light, the hardware processor is further configured to selectively switch the color of the probe light by switching on and off the at least three monochromatic light sources.
Claim element	Claim 5
[Claim 5]	The handheld intraoral scanner according to claim 1, wherein the optical system is configured to direct the probe light towards the object in a direction substantially parallel with the longitudinal axis of the tip, and wherein the tip further comprises a single reflective mirror that is configured to reflect the probe light towards the object.
Claim element	Claim 6
[Claim 6]	The handheld intraoral scanner according to claim 1, wherein the hardware processor is further configured to: 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 processed data for the 3D geometry.
Claim element	Claim 7
[Claim 7]	The handheld intraoral scanner according to claim 1, wherein the hardware processor is further configured to: 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 element	Claim 8
[Claim 8]	The handheld intraoral scanner according to claim 6, wherein the hardware processor is further configured to process the raw 3D data into data for the 3D geometry in real time.
Claim element	Claim 13
[Claim 13]	The handheld intraoral scanner according to claim 1, wherein the hardware processor is further configured to: output data from the one or more motion sensors for stitching and/or registering partial scans to one another.
Claim element	Claim 14
[Claim 14 pre]	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:
[Claim 14a]	a tip configured to be inserted into the oral cavity;
[Claim 14b]	at least one camera accommodating an array of sensor elements;
[Claim 14c]	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;
[Claim 14d]	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 . . .
[Claim 14e]	an optical system configured 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
[Claim 14f]	wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;
[Claim 14g]	a hardware processor, located within the wireless intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times;

[Claim 14h]	a hardware processor, located within the wireless intraoral scanner, configured to: ... record images of the object with the different colors by recording different images by the at least one camera at the different times;
[Claim 14i]	a hardware processor, located within the wireless intraoral scanner, configured to: ... process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and
[Claim 14j]	a hardware processor, located within the wireless intraoral scanner, configured to: ... 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 element	Claim 15
[Claim 15]	The handheld intraoral scanner of claim 14, wherein the hardware processor is further configured to process the raw 3D data into data for the 3D geometry in real time.
Claim element	Claim 16
[Claim 16]	The handheld intraoral scanner of claim 14, further comprising: one or more motion sensors located on the intraoral scanner to measure three-dimensional motion of the intraoral scanner.
Claim element	Claim 18
[Claim 18]	The handheld intraoral scanner according to claim 16, wherein the hardware processor is further configured to: output data from the one or more motion sensors for stitching and/or registering partial scans to one another.
Claim element	Claim 19
[Claim 19]	The handheld intraoral scanner according to claim 14, wherein the light source further comprises at least three monochromatic light sources configured to provide the different colors.
Claim element	Claim 20
[Claim 20]	The handheld intraoral scanner according to claim 14,

	wherein the hardware processor is further configured to selectively switch the color of the probe light by switching on and off the at least three monochromatic light sources.
Claim element	Claim 22
[Claim 22]	The handheld intraoral scanner according to claim 14, wherein the optical system is further configured to direct the probe light towards the object in a direction substantially parallel with the longitudinal axis of the tip, and wherein the tip further comprises a single reflective mirror that is configured to reflect the probe light towards the object.
Claim element	Claim 26
[Claim 26 pre]	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:
[Claim 26a]	a tip configured to be inserted into the oral cavity;
[Claim 26b]	at least one camera accommodating an array of sensor elements;
[Claim 26c]	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;
[Claim 26d]	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 . . . ;
[Claim 26e]	an optical system configured 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,
[Claim 26f]	wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;
[Claim 26g]	one or more motion sensors located on the intraoral scanner to measure three-dimensional motion of the intraoral scanner; and

[Claim 26h]	a hardware processor, located within the wireless intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; and
[Claim 26i]	a hardware processor configured to: . . . record images of the object with the different colors by recording different images by the at least one camera at the different times.
Claim element	Claim 28
[Claim 28]	The handheld intraoral scanner according to claim 26, wherein the hardware processor is further configured to: output data from the one or more motion sensors for stitching and/or registering partial scans to one another.
Claim element	Claim 29
[Claim 29]	The handheld intraoral scanner according to claim 26, wherein the intraoral scanner is wireless and the hardware processor is further configured to: 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.

I. INTRODUCTION

Medit Corporation (“Petitioner”) petitions for institution of *inter partes* review (“IPR”) of claims 1-3, 5-8, 13-16, 18-20, 22, 26, 28, and 29 (“challenged claims”) of U.S. Patent No. 11,368,667 (“the ’667 patent”). Ex-1001.

II. GROUNDS FOR STANDING

Petitioner certifies that the ’667 patent is available for review under 35 U.S.C. § 311(c) and that Petitioner is not estopped from requesting IPR of the challenged claims on the grounds identified in this Petition.

III. FEES

The Commissioner is hereby authorized to charge or credit the fee specified by 37 C.F.R. § 42.15(a), and any other additional fees, to Bracewell LLP Deposit Account No. 50-0259.

IV. THE PRECISE RELIEF REQUESTED

Petitioner requests review of the challenged claims under 35 U.S.C. § 311 and cancellation of the challenged claims under pre-AIA 35 U.S.C. § 103(a) in view of the prior art and grounds described herein.

A. The Prior Art

1. Orametrix

Petitioner relies on WIPO Publication No. 01/84479 A1 (“Orametrix”). Ex-1005. Orametrix was published on November 8, 2001, more than a year before the

alleged priority date for the '667 patent, and qualifies as a prior art printed publication under at least pre-AIA 35 U.S.C. § 102(b).

2. Faul

Petitioner relies on U.S. Patent No. 7,336,375 ("Faul"). Ex-1004. Faul was issued on February 26, 2008, more than a year before the alleged priority date for the '667 patent, and qualifies as a prior art printed publication under at least pre-AIA 35 U.S.C. § 102(b).

3. Breton

Petitioner relies on U.S. Patent No. 6,008,905 ("Breton"). Ex-1003. Breton was published on December 28, 1999, more than a year before the alleged priority date for the '667 patent, and qualifies as a prior art printed publication under at least pre-AIA 35 U.S.C. § 102(b).

4. Knighton

Petitioner relies on U.S. Publication No. 2005/0237581 ("Knighton"). Ex-1008. Knighton was published on October 27, 2005, more than a year before the alleged priority date for the '667 patent, and qualifies as a prior art printed publication under at least pre-AIA 35 U.S.C. § 102(b).

B. IPR Grounds

Ground	Claims	Statutory Basis
1	1-3, 5-8, 13-16, 18-20,	Obviousness under pre-AIA § 103(a) in view

Ground	Claims	Statutory Basis
	22, 26, 28, and 29	of Orametrix, Faul, Breton, and Knighton

V. THE '667 PATENT

A. Overview of the '667 Patent

The '667 patent describes a scanner configured to measure the shape and color of an object, such as teeth. *See, e.g.*, Ex-1001 at Abstract; 1:26-32; claim 1. The scanner obtains the shape and color of a scanned object surface. *Id.* at 2:46-48; 33:50-34:22. Figure 8 illustrates an example embodiment of a scanner:

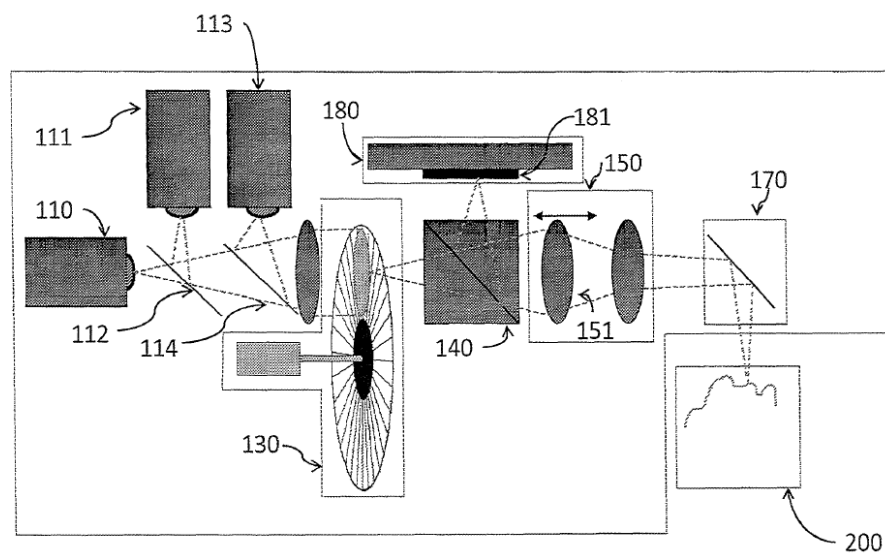


Fig. 8

The scanner includes pattern generator 130, which is used to generate a time-varying pattern that is projected onto the surface of scanned object 200. *Id.* at 3:10-17; 8:38-59; 10:53-55; 28:3-13; 29:46-61. Focusing element 151 moves to obtain images of the projected pattern on the object at different focus positions. *Id.* at 3:37-49; 6:64-7:53; 11:64-12:1; 27:31-36. These images are then used to determine the

3D surface information. *See, e.g., id.* at 3:62-4:7.

Three light sources (110, 111, 113) emitting red, blue, and green light are used to determine object color. *See e.g., id.* at 33:49-34:4. The surface color is determined by weighting the detected amplitude signals for each color. *Id.* at 34:1-4.

The '667 patent briefly discusses a wireless configuration that increases the need for local data processing because wireless transmission of raw 3D data is to be avoided. *Id.* at 9:19-26. The '667 patent also mentions that motion sensors can be used to detect scanner motion. *Id.* at 24:11-48.

B. Prosecution History

The claims that issued for the '667 patent were added by preliminary amendment before examination, and the issued claims were allowed by the examiner on the first office action. Ex-1002. The '667 patent has been terminally disclaimed with respect to several of the patents to which the '667 patent claims priority, including U.S. Patent No. 11,076,146. Ex-1012.

VI. LEVEL OF ORDINARY SKILL IN THE ART

As of June of 2009, the priority date of the '667 patent, a POSITA would have had a bachelor's degree in computer engineering, computer science, electrical engineering, physics, or an equivalent field, as well as at least one or two years of

design experience, or alternatively, at least five years of comparable industry experience. Ex-1013 ¶¶ 57-59. Furthermore, a POSITA would have had experience with, and knowledge of, 3D imaging systems and 3D modeling techniques. *Id.*

VII. CLAIM CONSTRUCTION

In an IPR, claim terms should be construed according to the *Phillips* standard. *See Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); *see also* 37 C.F.R. § 42.100(b). The Board need only construe terms to the extent necessary to resolve a controversy. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

For purposes of this proceeding only, Petitioner submits constructions for the following terms.¹ Petitioner does not believe that construction of any other term is necessary.

¹ While Petitioner proposes these constructions for purposes of this proceeding, Petitioner reserves its right to revise or amend these constructions in any other action or forum. *Western Digital Corp. v. Spex Techs., Inc.*, IPR2018-00084, Paper 14 at 11 (PTAB April 25, 2018). Petitioner also reserves the right to challenge the validity of the challenged claims under 35 U.S.C. § 112 in another other action or

A. The Preambles to Independent Claims 1, 14, and 26 Are Not Limiting

The District Court has determined that the preambles of independent 1, 14, and 26 are not limiting and should be afforded their plain and ordinary meanings. Ex-1006 at 4.

B. “data for the 3D geometry” (Claims 8, 15)

Claims 8 and 15 recite “data for the 3D geometry.” The District Court has construed “data for the 3D geometry” to mean “the data for the 3D geometry.” Ex-1006 at 4.

VIII. OVERVIEW OF THE PRIOR ART

A. Prior Art References

1. Orametrix

Orametrix describes systems and methods for scanning an object surface and generating a three-dimensional model of the scanned surface utilizing triangulation. *See, e.g.*, Ex-1005 at 1:16-21; 46:3-14; 82, Claim 32. The scanning in Orametrix is accomplished through projecting patterns that cast structured light onto a surface to be scanned. *Id.* at 25:11-16:5; 27:8-21; 29:8-19; Figs. 16, 19, 23. As depicted below

forum. *See Target Corp. v. Proxicom Wireless, LLC*, IPR2020-00904, Paper 11 at 12-13 (PTAB Nov. 10, 2020).

in Figure 23, the projected patterns include both measuring features, *e.g.*, (elements 1011-1013 at T1), and encoding features, *e.g.*, (elements 1021-1023 at T2).

SHAPE NUMBER	BAR CODE	COLOR	PATTERN
0		RED	
1		ORANGE	
2		YELLOW	
3		GREEN	
4		BLUE	
5		INDIGO	
6		VIOLATE	
7		BROWN	

FIGURE 16

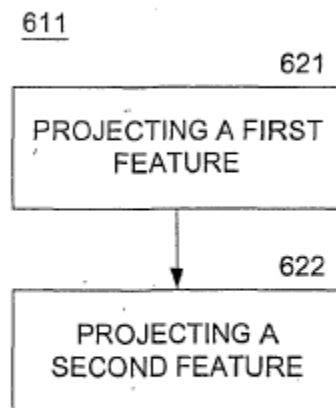


FIGURE 19

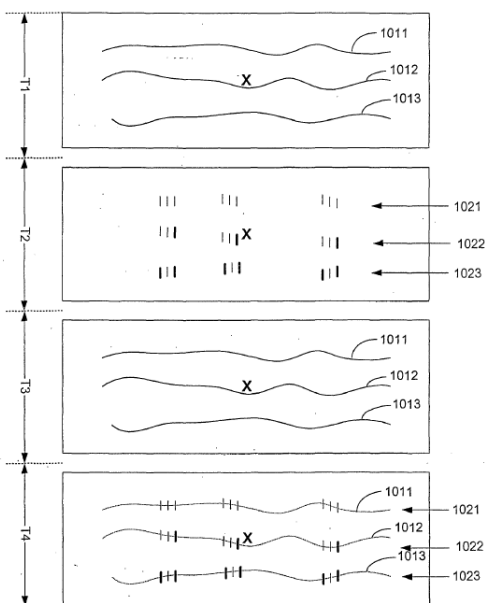
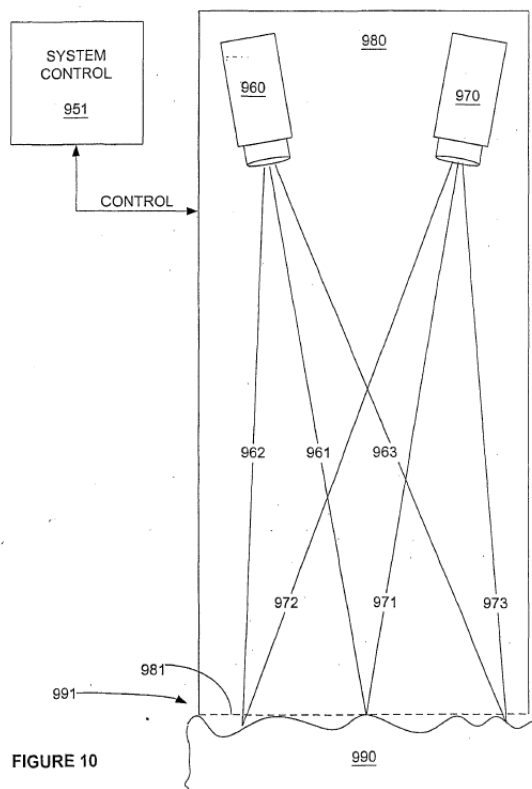


Figure 23

As shown between T1 and T4 in Figure 23, the projected patterns can vary in shape. Reflections from the surface of multiple two-dimensional images of the patterns are imaged by a high speed camera. *Id.* at 4:3-10; 16:6-13; 34:1-21. From these two dimensional images, the shape of the scanned surface is determined. *Id.* at 1:15-20; 15:19-21; 30: 15-23; Fig. 10.



Orametrix also describes an intermediary step of adding photo data containing color information to the scan data underlying the three-dimensional virtual model, so that color can also be determined for the model, which may be pertinent to the intended application of the model (e.g., design and manufacture of an anatomical device). *Id.* at 66:6-15.

Orametrix describes a registration process for stitching together adjacent image frames to form an integrated map of the scanned object surface. *Id.* at 24:3-10; 37:11-40:14; Fig. 36. This registration process includes consideration of

probable scanner movement. *See id.* at 37:11-40:14; Fig. 36. Orametrix describes stitching together 3D models from a plurality of scans. *See, e.g., id.* at 60:18-61:7.

Orametrix also illustrates the scanning device in a handheld configuration, described, for example in 56:11-22, and depicted, for example, by element 4401 in Figure 44:

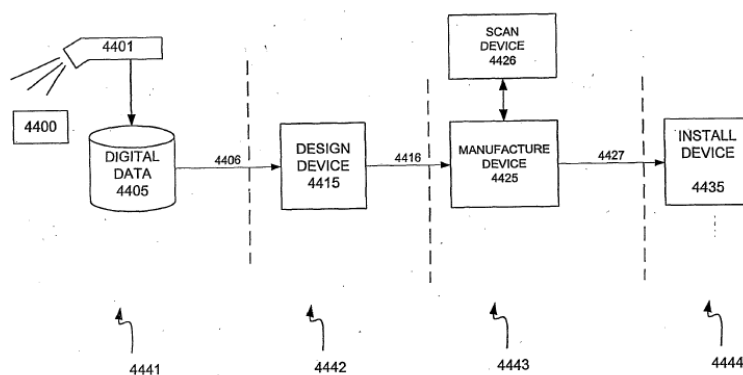
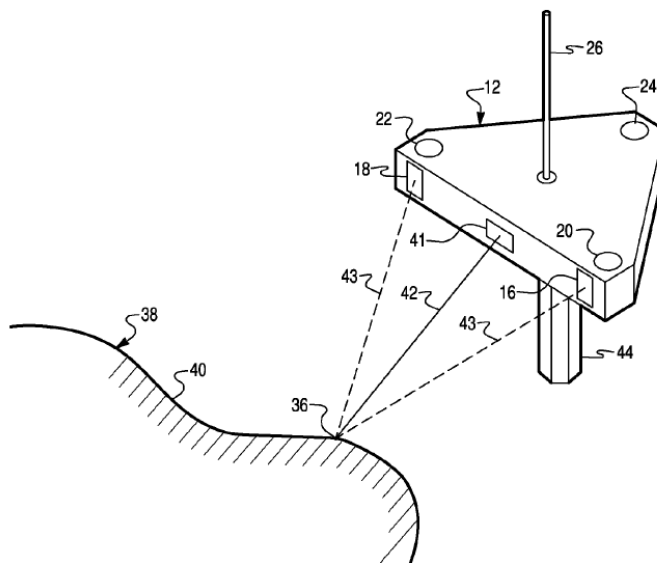


FIGURE 44

2. Faul

Faul teaches a handheld scanner for three-dimensional shape sensing utilizing projected structured light and triangulation. *See, e.g.*, Ex-1004 at Abstract; 1:61-2:15; 5:38-41; 7:29-31; 16:58-59; Figs. 2, 5.

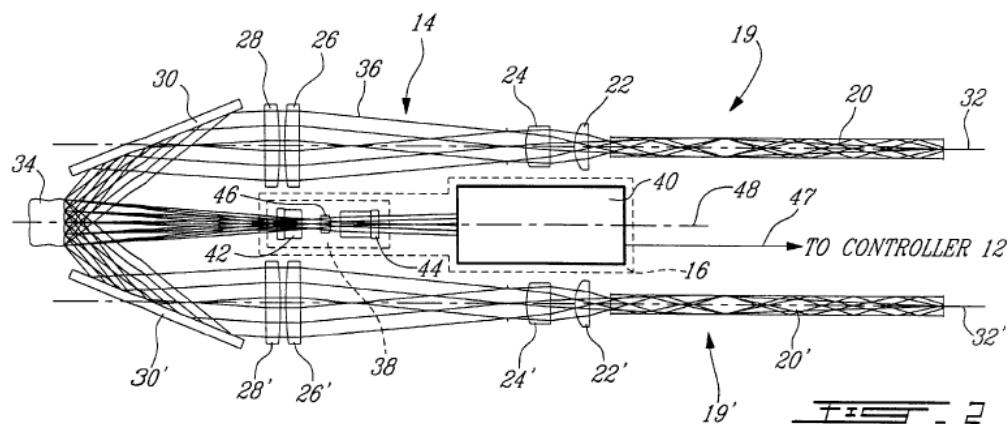
Fig. 2



59. This shape determination is made by projecting dynamically-varied, structured light on a surface to be measured by means of a digital video projector. See *id.* at 4:36-53. Faul also describes dynamically altering the color of the projected structured light. See, e.g., *id.* at 6:60-67; 10:64-11:4. Reflections of the structured light projections from the scanned surface are detected by at least one optical imaging sensor to determine the color and shape of the surface. *Id.* at 4:59-5:9; 5:38-51; 6:60-67; Fig. 2. Faul describes performing processing within the wireless scanner to reduce the amount of transmitted data. See, e.g., *id.* at 12:43-63.

3. Breton

Breton describes a method and apparatus for determining the color and shape of a scanned object, such as a tooth. See, e.g., Ex-1003 at Abstract; 5:35-55; Fig. 2.



The wavelength of the light emitted by illumination assembly 14 is stepped over a range in order to change the color of the projected light that is used to scan the surface of object 34. *Id.* at 6:62-7:20. Illumination assembly 14 includes multiple light sources (not pictured). *Id.* at 4:16-26. The shape of surface 34 is determined by building a position registry. *Id.* at 7:39-52. This position registry corresponds to a spectral map built from a complete spectral decomposition of every scanned point. *Id.* The combination of the position registry and spectral map determines the shape and color of the scanned surface. *Id.* Breton also discloses that the color of teeth can be accurately measured only using 3 sampling bands in red, blue, and green bandwidths, which can reduce computation time. *Id.* at 8:24-36.

4. Knighton

Knighton describes a wireless, hand-held portable three-dimensional scanner.

See, e.g., Ex-1008 at Abstract; [0033]; Fig. 1.

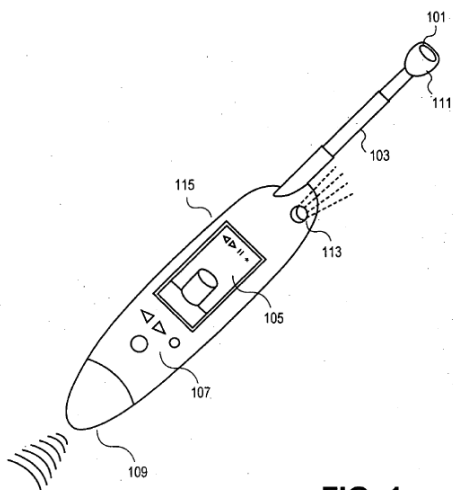


FIG. 1

Knighton describes imaging a surface and tracking the position of the scanner in order to determine a composite image that can be processed to generate a three-dimensional representation of the scanned object, which may be a tooth. *Id.* at Abstract; [0047]; [0051]-[0059]. Knighton also describes that this 3D representation can be produced either internally by the scanning device, or externally at a workstation. *See, e.g., id.* at [0093]. Knighton also describes that the data for the 3D data may be stored in an intermediate state within the scanner for further processing. *Id.* Knighton describes that processing overhead can be reduced by processing only the pixels of the composite image in order to generate the depth map that corresponds to the three-dimensional representation of the scanned object. *See id.* at [0052]. Knighton also describes that the position of the scanner may be

measured using sensors that may include a gyroscope, GPS device, altimeter, or accelerometer for detecting the orientation and position of the scanner in 3D space. *Id.* at [0044]. This position data from the scanner is correlated to the 3D representation of the scanned surface. *See, e.g., id.* at [0080], [0082].

B. A POSITA Would Have Been Motivated to Combine the Prior Art

As explained in the attached declaration of Dr. Rongguang Liang a POSITA would have been motivated to combine Orametrix, Faul, Breton, and Knighton and have a reasonable likelihood of success in making said combination. Ex-1013 ¶¶ 64-68.

Orametrix, Faul, and Knighton all recognize the need for obtaining accurate scans of objects for three-dimensional modeling and mapping. For example, Orametrix describes the need for accurate three-dimensional models to develop medical and dental devices and appliances that will reduce the level of subjective criteria required in manufacturing or reproducing them. *See, e.g.,* Ex-1005 at 1:17-22; 2:1-3:20. Similarly, Faul describes the desirability of obtaining three-dimensional models of real-world objects that are enhanced through wireless optical scanning, which does not require cables or other mechanical linkage or any physical contact with the object. *See, e.g.,* Ex-1004 at 1:18-34; 2:36-39; 2:42-3:32; 15:16-19. Knighton describes an advantage of three-dimensional imaging being that high

resolution images of a scanned surface can be obtained that reveal features that appear homogeneous to the human eye. *See, e.g.*, Ex-1008 at [0047].

As with Orametrix, Breton describes the need to obtain an objective three-dimensional model of a tooth to create an accurate reproduction for a replacement tooth that minimizes subjectivity. *See, e.g.*, Ex-1003 at 1:14-40. Breton discusses the difficulty in matching the color shade of a reproduction tooth. *Id.* at 1:29-34.

In sum, Orametrix, Faul, Breton, and Knighton, all describe measuring systems for acquiring the color and shape of scanned objects. Ex-1013 ¶ 66. These four references belong to the same technical field, provide similar scanning systems, and have the same purpose to increase objectivity and accuracy in three-dimensional modeling of real-world objects. *Id.*, ¶¶ 64, 66. Therefore, a POSITA would have been motivated to combine the various elements of Orametrix, Faul, and Breton to achieve accurate color and shape measurements in three-dimensional models of scanned objects. *Id.*, ¶ 64. A POSITA would also recognize the motion and position tracking advantages of the wireless scanning system taught by Knighton would apply to the scanners taught by Orametrix and Faul, even though Knighton describes different scanning and imaging methods for generating a three-dimensional image. *Id.* Furthermore, a POSITA would have had a reasonable expectation of success in combining the features and teachings of Orametrix, Faul, Breton, and Knighton,

because these optical systems already share similar features and components, and the substitution and combinations of features would be simple and yield the expected results of more accurate and objective optical measurements to make three-dimensional models of real-world objects. *Id.*, ¶ 67.

IX. THE CHALLENGED CLAIMS ARE UNPATENTABLE AND SHOULD BE CANCELLED

A. Claims 1-3, 5-8, 13-16, 18-20, 22, 26, 28, and 29 Are Rendered Obvious by Orametrix In View of Faul, Breton, and Knighton

1. Claim 1 Is Rendered Obvious by Orametrix In View of Faul, Breton, and Knighton

- a. [Claim 1 pre]: “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:”**

The District Court determined that the preamble of claim 1 is not limiting. *See supra* Section VII.A. Nevertheless, Orametrix teaches this limitation. Orametrix teaches a scanning system for determining the shape and color of tooth in an oral cavity. *See, e.g.*, Ex-1005 at 1:15-22; 15:19-21; 30:15-23; 31:11-33:7; 66:6-15. Figs. 10, 27, 28, 29; Ex-1013 ¶ 70. Orametrix further teaches that the scanner would be held by a user, for example, a user in a home setting. *See, e.g.*, Ex-1005 at 58:1-14; Ex-1013 ¶ 70.

b. [Claim 1a]: “a tip configured to be inserted into the oral cavity;”

Orametrix describes a scanning device 4401 that shows a tip, as illustrated in Figure 44:

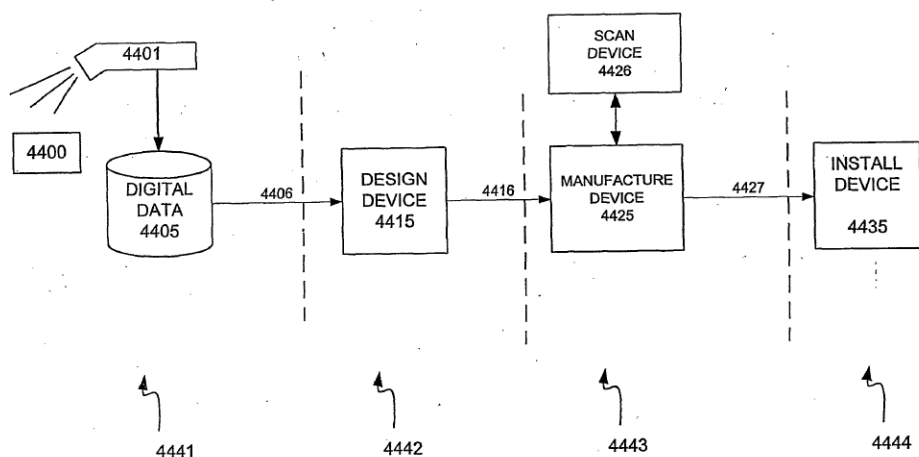


FIGURE 44

Ex-1013 ¶ 71. Orametrix further discloses that the anatomical structure, such as a tooth, can be scanned directly by scanner 4401. Ex-1005 at 56:11-20; *see also id.* at 31:11-19; Fig. 27 (describing scanning a tooth surface); Ex-1013 ¶ 72. The scanner illustrated in Figure 44, in combination with the description of direct scanning of anatomical structures teaches the claimed “tip” limitation. Ex-1013 ¶ 72. Furthermore, a POSITA would understand that in order to facilitate direct scanning of an anatomical structure, such as a tooth in a mouth, a housing that includes a tip would be needed to protect the scanning optics from damage or debris. Ex-1013 ¶

73. Therefore, Orametrix renders obvious this element of claim 1. *Id.*

c. [Claim 1b]: “at least one camera accommodating an array of sensor elements;”

Orametrix teaches a camera or viewer for capturing the reflected projected structured light pattern from an object to be scanned, including a CCD (charge coupled device). Ex-1005 at 4:3-10; 16:6-13; 34:4-6; Ex-1013 ¶ 74. A POSITA would understand the camera/viewer of Orametrix would necessarily include an array of sensor elements. Ex-1013 ¶ 74. Therefore, Orametrix renders obvious this claim element. Ex-1013 ¶ 75.

d. [Claim 1c]: “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;”

Orametrix describes system controller 951 which includes data processor 952, projection image representation 953, projector controller 954, and viewer controller 955. Ex-1005 at 16:19-22; Figs. 10, 11; Ex-1013 ¶ 76. System controller 951 provides specific information to scanner 980 specifying a specific image to be projected onto surface 991 of object 990. Ex-1005 at 15:19-21; Ex-1013 ¶ 76. Orametrix describes that the image to be projected can be a digital image that is stored in memory by data processor 952. Ex-1005 at 17:11-19; Ex-1013 ¶ 76. Orametrix further describes that in the scanning process, different patterns can be

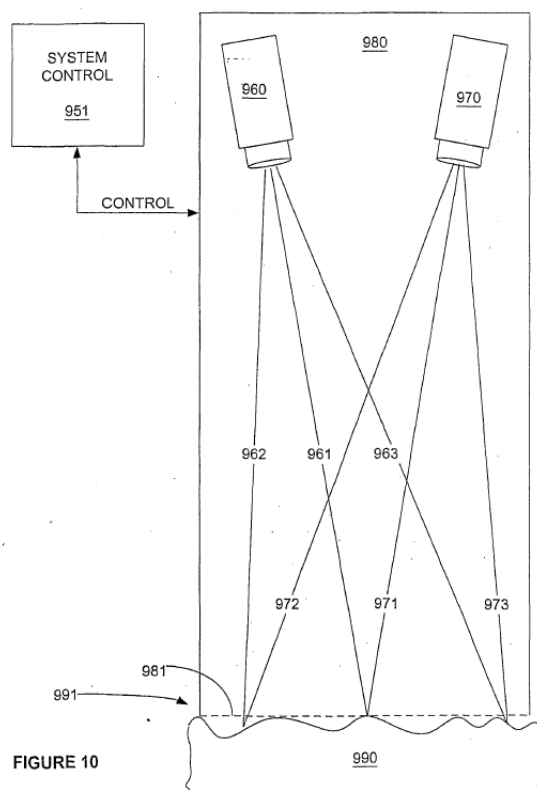
projected over different periods of time. Ex-1005 at 29:8-19; Figs. 16, 19, 23; Ex-1013 ¶ 76. Orametrix teaches that changing the projected patterns with different encoding and measuring features over time allows for more information to be obtained about the surface. Ex-1005 at 29:8-19; Figs. 16, 19, 23; Ex-1013 ¶ 76.

Faul also describes projecting a time-varying pattern of structured light to determine the shape of an object. *See* Ex-1004 at 4:36-53; Ex-1013 ¶ 77. Faul describes that the time-varying pattern can be generated by a digital video projector. Ex-1004 at 4:25-53; 5:53-54; Ex-1013 ¶ 77. Faul discloses that the scanner includes a microprocessor and memory, Ex-1004 at 7:64-8:8, and a POSITA would understand that this microprocessor would be utilized to implement the measurement process, including light source and camera control, as well as image processing. Ex-1013 ¶ 77.

A POSITA would have considered the digital image projection of Orametrix or Faul's projected pattern of structured light to be "a probe light with a plurality of configurations in the form of a time-varying illumination pattern," as claimed. Ex-1013 ¶ 78. Thus, Orametrix and Faul each teaches, and therefore renders obvious the elements recited in claim 1. *Id.*

- e. **[Claim 1d]: “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 . . .”**

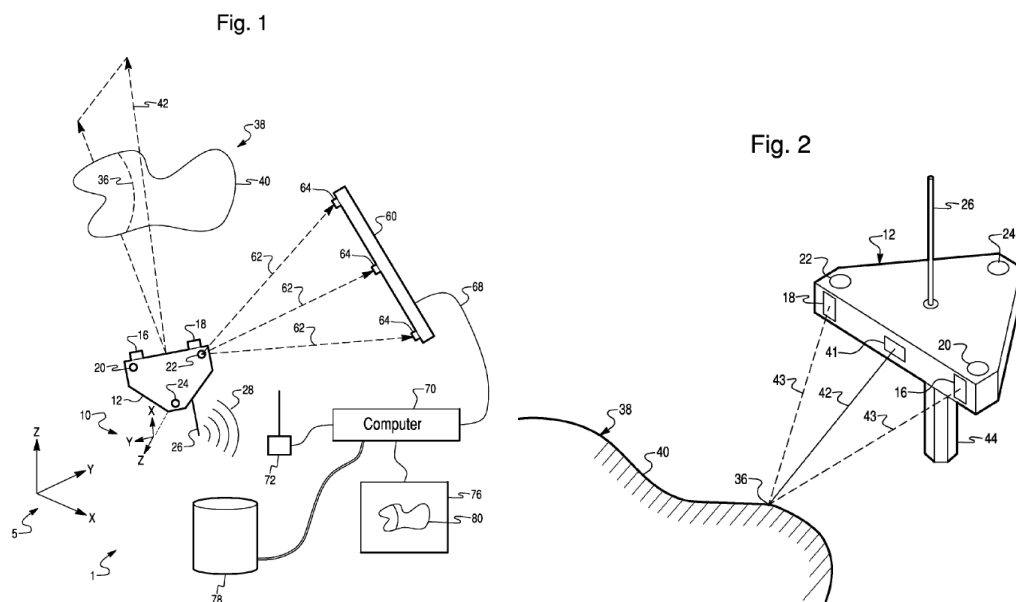
Figure 10 of Orametrix illustrates an optical system according to this claim element:



Ex-1013 ¶ 79. As illustrated above, Orametrix shows projector 960 that transmits the patterned probe light beam along an optical path to the surface of object 990 thereby illuminating at least a part of the object with the time-varying illumination pattern. Ex-1005 at 16:6-13; Ex-1013 ¶ 80. The reflected light from the object is

detected by viewing device 970. Ex-1005 at 16:6-13; Ex-1013 ¶ 80. Orametrix further describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. Ex-1005 at 30:7-8; Ex-1013 ¶ 80. The 2D image frames are then converted into 3D using conventional 3D imaging techniques. Ex-1005 at 30:8-12; *see also id.* at 75 (claim 4); Ex-1013 ¶ 80. Also, a POSITA would understand that the scanner of Orametrix would have a tip for directing the scanning illumination towards a tooth in a mouth. *See supra* Section X.A.1.b; Ex-1013 ¶ 80.

Faul also describes the elements of this claim limitation. Ex-1013 ¶ 81
Figures 1 and 2 of Faul illustrate the claimed optical system:



Ex-1013 ¶ 81. As illustrated above, Faul describes a light source 41 projected on an optical path to a surface 36 from which reflected light is detected by at least one

imaging sensor 16 or 18. Ex-1004 at 4:59-5:3; 8:45-9:25; 10:37-60; Ex-1013 ¶ 81. Faul describes the two-dimensional video data based on the reflected time-varying pattern that are detected by 16 or 18 are used as the basis for a three-dimensional model of the scanned surface. Ex-1004 at 4:59-9:25; 7:11-29; Ex-1013 ¶ 82.

A POSITA would recognize that Orametrix’s projector 960 and Faul’s light source 41 are both “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,” as recited by this claim element. Ex-1013 ¶ 82. Therefore, Orametrix and Faul each renders this claim element obvious. *Id.*

f. [Claim 1e] “an optical system configured 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”

Orametrix describes that light projected by projector 960 reflected from the surface of object 990 is detected by viewing device 970. *See supra* Section IX.A.1.e. *See also* Ex-1005 at 16:6-13; Fig. 10; Ex-1013 ¶ 84.

Faul describes that projected light from light source 41 is projected onto surface 36, the reflection of which is then detected by imaging sensor 16 or 18. Ex-1004 at 4:59-5:3; 8:45-9:25; 10:37-60; Ex-1013 ¶ 85.

A POSITA would recognize that Orametrix’s viewing device and Faul’s

imaging sensors, in combination with the optical path of reflected light from surface, comprise “an optical system configure 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 . . .,” as recited in this claim element. Ex-1013 ¶ 86. Therefore, Faul and Orametrix each renders this claim element obvious. *Id.*

g. [Claim 1f]: “wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;”

Orametrix describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. *See supra* Section IX.A.1.e. *See also* Ex-1005 at 30:7-8; Ex-1013 ¶ 88. The 2D image frames are then converted into 3D using conventional 3D imaging techniques. Ex-1005 at 30:8-12; *see also id.* at 75 (claim 4); Ex-1013 ¶ 88.

Faul describes the two-dimensional video data based on the reflected time-varying pattern that are detected by 16 or 18 are used as the basis for a three-dimensional model of the scanned surface. Ex-1004 at 4:59-5:9; 5:38-41; 6:24-42; 7:11-29; Ex-1013 ¶ 89.

A POSITA would recognize that Orametrix’s 2D image frame conversion and Faul’s two-dimensional video data analysis teach that “the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination

pattern,” as recited in this claim element. Ex-1013 ¶ 90. Therefore, Orametrix and Faul each renders this claim element obvious. *Id.*

h. [Claim 1g]: “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”

Orametrix describes the direct measurement of anatomical structures, including teeth. Ex-1005 at 31:11-19; 56:11-20; Ex-1013 ¶ 91. Orametrix describes wirelessly communicating scanning data from the system to a client. Ex-1005 at 58:21-59:13; Fig. 44; Ex-1013 ¶ 92. This client may be, for example, design device 4415 at facility 4442, which is a workstation located remotely from scanner 4401. Ex-1005; *see also id.* At 62:19-21; 63:11-18 (describing facility 4442); Ex-1013 ¶ 91. The scan data may be a dental structure, and Orametrix describes an example where the scanner may be performed at home by a user for monitoring the progress of a treatment plan. Ex-1005 at 58:1-14; Ex-1013 ¶ 91. Orametrix also describes an embodiment where probable movement of the scanner in the X, Y, and Z directions is determined. *See, e.g.,* Ex-1005 at 37:11-38:13; Ex-1013 ¶ 91. This movement data is used in the modeling process to perform registration between image frames. Ex-1005 at 38:18-41:9; Ex-1013 ¶ 92. Given this disclosure, and in light of the descriptions of the scanner in Faul and Knighton, a POSITA would understand that Orametrix’s scanner would be wireless and communicating data

wirelessly for remote processing. Ex-1013 ¶ 91.

Faul explicitly teaches the advantages of a wireless handheld scanner for obtaining scanning data of 3D shapes in that it is unencumbered by a cable or mechanical linkage. *See, e.g.*, Ex-1004 at 2:36-39; 3:44-45; 6:43-50; Ex-1013 ¶ 92. Faul also teaches that the position of the scanner can be tracked by any sort of 3D tracking system, including non-optical tracking systems. *See, e.g.*, Ex-1004 at 8:45-60; Ex-1013 ¶ 92. This position data is used to generate a set of 3D surface point coordinates that are used to model the scanned objects surface in 3D. *See, e.g.*, Ex-1004 at 3:11-24; 9:27-60; Ex-1013 ¶ 92.

Knighton teaches a wireless, handheld optical scanning system that includes position tracking sensors in the scanner itself that may include gyroscopes, GPS devices, altimeters, and accelerometers. *See supra* Section VIII.A.4. *See, e.g.*, Ex-1008 at [0044]; *see also id.* At [0033], [0045] (describing wireless configurations); Ex-1013 ¶ 93. Knighton further discloses that position and movement data may be generated by these sensors. Ex-1008 at [0044]; Ex-1013 ¶ 93. Data from the position tracking sensors is used to correlate a scanned depth map to a three-dimensional representation of the surface to be scanned. Ex-1008 at [0080], [0082]; Ex-1013 ¶ 93.

It would have been obvious to a POSITA to configure the scanner of

Orametrix with the wireless configurations taught by Faul because Orametrix already contemplates the wireless transmission of data, and Faul teaches that making the handheld scanning unit wireless allows the user to scan objects without mechanical linkage or cables, which would facilitate easier direct measurements of teeth in a mouth. Ex-1013 ¶ 94.

Furthermore, it would have been obvious to include the non-optical position tracking sensors, as taught by Knighton in the wireless scanner of Orametrix in combination with Faul, in order to obtain accurate position and movement data to be used in the three-dimensional modeling of the scanned surface. Ex-1013 ¶ 95. Therefore, Orametrix in view of Faul and Knighton teaches this claim element. Ex-1013 ¶ 96.

- i. **[Claim 1h]: “a hardware processor, located within the wireless intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; and”**

As described above in Section IX.A.1.d, Orametrix describes scanning the object surface with a time-varying pattern to determine shape information. Ex-1013 ¶ 97. Furthermore, Orametrix describes changing the color of projected encoded features used for registration in multiframe scanning. Ex-1005 at 14:13-17; 25:11-26:5; Fig. 16; Ex-1013 ¶ 97. Orametrix also describes that photo data containing

color information can be added to the digital data of the 3D virtual model of the anatomical structure. Ex-1005 at 64:6-15; Ex-1013 ¶ 97. Orametrix teaches that the measurement techniques may be implemented and executed by a hardware processor as part of the system. Ex-1005 at 16:19-22; 64:6-15; 69:15-70:10; Fig. 46; Ex-1013 ¶ 97.

Faul also describes projecting a time-varying pattern to determine the shape of an object. *See* Ex-1004 at 4:36-53; Ex-1013 ¶ 98. Faul describes a digital video projector for generating a time-varying pattern. Ex-1004 at 4:25-53; 4:36-52; Ex-1013 ¶ 98. Faul also describes measuring the color of the scanned surface. *See, e.g.,* Ex-1004 at 6:60-67; Ex-1013 ¶ 98. Faul also describes dynamically altering the color of the projected structured light. *See* Ex-1004 10:64-11:4; Ex-1013 ¶ 98. Faul discloses that the scanner includes a microprocessor, Ex-1004 at 7:49-8:8, thus, a POSITA would understand that this microprocessor would be utilized to implement the measurement process, including light source and camera control, as well as image processing. Ex-1013 ¶ 98.

Breton describes changing the wavelength of projected light from a controlled monochromatic light source over time to illuminate the scanned object with different colors at different times to measure the color of the surface of the scanned object. *See, e.g.,* Ex-1003 at 6:62-7:20; Fig. 2; Ex-1013 ¶ 99. Breton describes that the

wavelength of the light source needs to be stepped through a number of discrete spectral bands at a maximum bandwidth in order to achieve adequate spectral resolution for the spectral map that corresponds to the color of the tooth surface. Ex-1003 at 6:62-7:20; Fig. 2; Ex-1013 ¶ 99. Breton further discloses that the color of the teeth can be accurately measured using only three sampling bands in the red, blue, and green portions of the wavelength spectrum, and that limiting the spectral bands can reduce computation time. Ex-1003 at 8:24-36; Ex-1013 ¶ 99.

It would have been obvious to a POSITA to combine the wavelength scanning of the monochromatic light source of Breton with time-varying pattern projection of Orametrix or Faul in order to measure the color of the scanned surface at an adequate spectral resolution, and therefore achieve an accurate color measurement. Ex-1013 ¶ 100. The processor of Orametrix is already configured to change the color of projected encoding features, and is configured to introduce color information from photo data into the three-dimensional model. Ex-1013 ¶ 100. And Faul itself teaches color measurement and suggests dynamically changing the color of the projected time-varying structured light. Ex-1013 ¶ 100. A POSITA would understand that the processors described by Orametrix and Faul would be configured to implement the color changing scheme as taught by Breton in the structured light projection in order to obtain sufficient spectral resolution to achieve an accurate color

measurement of the scanned object surface. Ex-1013 ¶ 100. Thus, Orametrix or Faul, further in view of Breton, teaches this claim element.

- j. **[Claim 1i]: “a hardware processor, located within the wireless intraoral scanner, configured to: ... record images of the object with the different colors by recording different images by the at least one camera at the different times.**

Both Orametrix and Faul teach recording images of the scanned surface at different times with different projected patterns. *See supra* Section IX.A.1.c . For example, Orametrix describes that the data may be a composite of scans taken at different times. Ex-1005 at 57:7-16; Ex-1013 ¶ 101. Likewise, Faul describes assigning timestamps to each scanned image. Ex-1004 at 14:7-39; Ex-1013 ¶ 101. Faul also describes recording images of the object with different colors. Ex-1004 at 12:20-30; Fig. 4 (describing data format 403 that includes RGB color intensities for each point in the image); Ex-1013 ¶ 101. APOSITA would be motivated to combine Breton’s color determination through wavelength scanning with either Orametrix or Faul in order to obtain sufficient spectral resolution in order to accurately measure the color of the scanned surface. *See supra*, Section IX.A.1.h; Ex-1013 ¶ 101. A POSITA would understand that the wavelength scanning of this combination would necessarily require recording different images at different times reflecting the stepped wavelength changes. Ex-1013 ¶ 101. Therefore, the combination of

Orametrix or Faul in view of Breton teaches this claim element. Ex-1013 ¶ 102.

2. Claim 2 Is Rendered Obvious by Orametrix In View of Faul, Breton, and Knighton

- a. [Claim 2]: “The handheld intraoral scanner according to claim 1, wherein the light source further comprises at least three monochromatic light sources configured to provide the different colors.”**

, Orametrix in view of Faul and Breton teaches changing colors of the projected structured light pattern. *See supra* Section IX.A.1.i Ex-1013 ¶ 104. Breton further describes that illumination assembly 14 contains a number of light sources that are not pictured. Ex-1003 at 3:53-56; 4:20-26; Ex-1013 ¶ 104. Breton also teaches the advantages of limiting the color band analysis to the red, blue, and green color bands to conserve processing resources. Ex-1003 at 11:21-27; Ex-1013 ¶ 104. A POSITA would have understood that the multiple light sources of Breton to include three monochromatic light sources to provide the red, blue, and green wavelength bands for scanning the object surface. Ex-1013 ¶ 104. Orametrix in view of Faul, Breton, and Knighton renders claim 2 obvious. Ex-1013 ¶ 104.

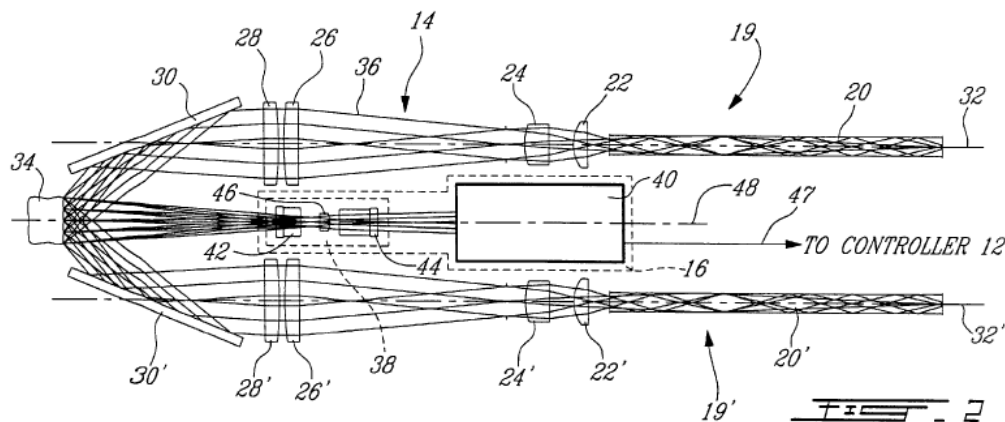
3. Claim 3 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. [Claim 3]: “The handheld intraoral scanner according to claim 2, wherein for the selectively switch the color of the probe light, the hardware processor is further configured to selectively switch the color of the probe light by switching on and off the at least three monochromatic light sources.”**

Breton describes an illuminator assembly comprised of multiple light sources. *See supra* Sections VIII.A.3, IX.A.1.i, and IX.A.2.a; Ex-1013 ¶ 107. Breton also teaches changing the wavelength of the light used to scan the tooth surface. Ex-1003 at 6:62-11; Ex-1013 ¶ 107. A POSITA would selectively switch the three monochromatic light sources in the combination of Orametrix, Faul, and Breton to obtain separate measurements of the red, blue, and green spectral bandwidths, and therefore obtain an accurate color measurement of the tooth surface while conserving computational resources. Ex-1013 ¶ 107. Therefore, Orametrix in view of Faul, Breton, and Knighton renders claim 3 obvious. Ex-1013 ¶ 108.

4. **Claim 5 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton**
 - a. **[Claim 5]: “The handheld intraoral scanner according to claim 1, wherein the optical system is configured to direct the probe light towards the object in a direction substantially parallel with the longitudinal axis of the tip, and wherein the tip further comprises a single reflective mirror that is configured to reflect the probe light towards the object.”**

As illustrated in Figure 2 of Breton, the measurement illumination is directed towards the tooth being measured in a direction parallel with the longitudinal axis of the device:



Ex-1013 ¶ 110. Breton also describes directing the measurement illumination from integrator rod 20 towards tooth surface 34 using mirror 30. Ex-1003 at 4:1-26; Ex-1013 ¶ 111. Breton teaches that this configuration minimizes specular reflection. Ex-1003 at 4:19-26; Ex-1013 ¶ 111. Breton also teaches that other illumination and mirror configurations could be utilized. Ex-1003; Ex-1013 ¶ 111. A POSITA would be motivated to include a single mirror, as taught by Breton, in the tip of the scanner of the combination of Orametrix and Faul in order to accurately scan the surface to be measured and avoid specular reflections. Ex-1013 ¶ 111. Therefore, Orametrix in view of Faul, Breton, and Knighton renders claim 5 obvious. Ex-1013 ¶ 112.

5. Claim 6 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. [Claim 6]: “The handheld intraoral scanner according to claim 1, wherein the hardware processor is further configured to: 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 processed data for the 3D geometry.”**

Orametrix and Faul describe determining the 3D geometry based on the plurality of 2D images. *See supra* Section IX.A.1.f; Ex-1013 ¶ 114. Faul describes processing two-dimensional image data locally in the scanning device to reduce the amount of data that is required to be transmitted from the scanning device to a workstation. Ex-1004 at 4:59-5:51; 12:43-50; Ex-1013 ¶ 115. Faul describes that subpixel coordinates of given points on the scanned 2D image are transformed into three-dimensional coordinates that are then transmitted. Ex-1004 at 12:27-32; Ex-1013 ¶ 115. Furthermore, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. *See supra* Section X.A.1.h; Ex-1013 ¶ 115. A POSITA would implement the local processing taught by Faul in the combined scanning system of Orametrix, Faul, and Breton to reduce the amount of data required to be transmitted wirelessly and increase overall processing speed for rendering the three-dimensional model of the scanned surface. Ex-1013 ¶ 115. Therefore, Orametrix in view of Faul, Breton, and Knighton renders claim 6 obvious.

Ex-1013 ¶ 116.

**6. Claim 7 Is Rendered Obvious by Orametrix in View of
Faul, Breton, and Knighton**

- a. [Claim 7]: “The handheld intraoral scanner according to claim 1, wherein the hardware processor is further configured to: 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.”**

Orametrix and Faul describe determining the 3D geometry based on the plurality of 2D images. *See supra* Section IX.A.1.g; Ex-1013 ¶ 118. Faul describes processing two-dimensional image data locally in the scanning device to reduce the amount of data that is required to be transmitted from the scanning device to a workstation. Ex-1004 at 4:59-5:51; 12:43-50; Ex-1013 ¶ 119. Faul teaches that subpixel coordinates of given points on the scanned 2D image are transformed into three-dimensional coordinates that are then transmitted. Ex-1004 at 12:27-32; Ex-1013 ¶ 119. Faul specifically describes this local processing as significantly reducing the amount of transmitted geometric and color data as compared to conventional transmission. Ex-1004 at 12:43-50; Ex-1013 ¶ 119. A POSITA would understand that this locally processed data is transmitted at a reduced data rate compared with what would be required to transmit the raw data before local

processing. Ex-1013 ¶ 119. Furthermore, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. *See supra* Section IX.A.1.h; Ex-1013 ¶ 119. A POSITA would implement the local processing taught by Faul in the combined scanning system of Orametrix, Faul, and Breton to reduce the amount of data required to be transmitted wirelessly and increase overall processing speed for rendering the three-dimensional model of the scanned surface. Ex-1013 ¶ 119. Therefore, Orametrix in view of Faul renders claim 7 obvious. *Id.* at ¶¶ 119-20.

7. Claim 8 Is Rendered Obvious by Orametrix in View of Faul, and Knighton

- a. [Claim 8]: “The handheld intraoral scanner according to claim 6, wherein the hardware processor is further configured to process the raw 3D data into data for the 3D geometry in real time.”**

Orametrix describes allowing for real-time viewing of a three-dimensional image of the scanned object. Ex-1005 at 34:12-15; Ex-1013 ¶ 122. Faul also describes rendering the geometry of a three-dimensional object in real-time. Ex-1004 at 8:56-60; Ex-1013 ¶ 122. Therefore, Orametrix and Faul each renders claim 8 obvious. Ex-1013 ¶¶ 122-23.

8. Claim 13 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. [Claim 13]: “The handheld intraoral scanner according to claim 1, wherein the hardware processor is further configured to: output data from the one or more motion sensors for stitching and/or registering partial scans to one another.”**

Orametrix describes using probable scanner position for registering and stitching partial scans of the object to create an integrated surface map of the object. *See supra* Sections VIII.A.1, IX.A.1.h; Ex-1013 ¶ 125. Furthermore, Orametrix in combination with Faul and Knighton teaches using motion sensors to track the motion and position of the scanner, and that the position and motion data is used in the calculation of the three-dimensional modeling of the scanned surface. *See supra* Section IX.A.1.h. Therefore, Orametrix in view of Faul and Knighton renders claim 13 obvious. Ex-1013 ¶¶ 125-26.

9. Claim 14 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. [Claim 14 pre]: “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:”**

The District Court determined that the preamble of claim 14 is not limiting. *See supra* Section VII.A. Orametrix teaches a scanning system for determining the shape and color of tooth in an oral cavity. *See, e.g.*, Ex-1005 at 1:15-22; 15:19-21;

30:15-23; 31:11-33:7; 66:6-15. Figs. 10, 27, 28, 29; Ex-1013 ¶ 128. Orametrix further teaches that the scanner would be held by a user, for example, a user in a home setting. *See, e.g.*, Ex-1005 at 58:1-14; Ex-1013 ¶ 128.

b. [Claim 14a]: “a tip configured to be inserted into the oral cavity;”

Orametrix describes a scanning device 4401 that shows a tip:

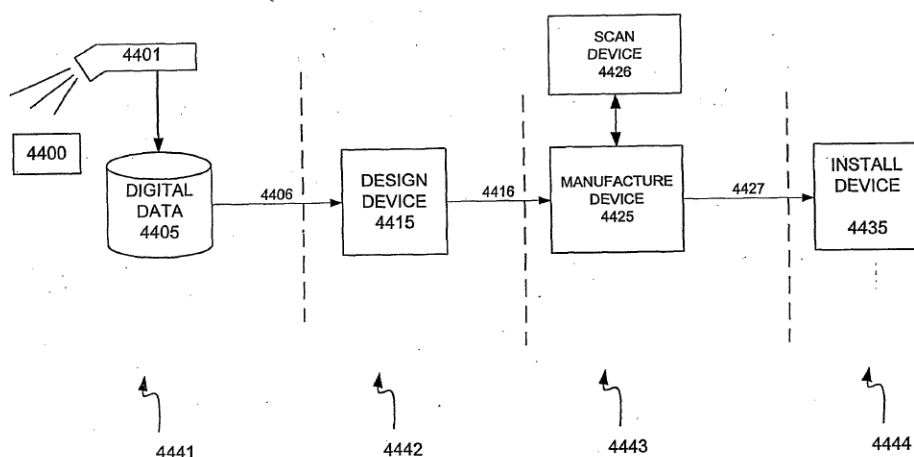


FIGURE 44

Ex-1013 ¶ 129. Orametrix further discloses that the anatomical structure, such as a tooth, can be scanned directly by scanner 4401. Ex-1005 at 56:11-20; *see also id.* at 31:11-19; Fig. 27; Ex-1013 ¶ 130. The scanner illustrated in Figure 44, in combination with the description of direct scanning of anatomical structures teaches the claimed “tip” limitation. Ex-1013 ¶ 130. Furthermore, a POSITA would understand that in order to facilitate direct scanning of an anatomical structure, such as a tooth in a mouth, a housing that includes a tip would be needed to protect the

scanning optics from damage or debris. *Id.* Therefore, Orametrix renders this element of claim 14 obvious. *Id.* at ¶¶ 130-31.

c. [Claim 14b]: “at least one camera accommodating an array of sensor elements;”

Orametrix teaches a camera or viewer for capturing the reflected projected structured light pattern from an object to be scanned, including a CCD. *See* Ex-1005 at 4:3-10; 16:6-13; 34:4-6; Ex-1013 ¶ 132. A POSITA would understand the camera/viewer of Orametrix would necessarily include an array of sensor elements. Ex-1013 ¶ 132. Therefore, Orametrix renders this claim element obvious. *Id.* at ¶¶ 133-34.

d. [Claim 14c]: “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;”

Orametrix describes system controller 951 which includes data processor 952, projection image representation 953, projector controller 954, and viewer controller 955. Ex-1005 at 16:19-22; Figs. 10, 11; Ex-1013 ¶ 134. System controller 951 provides specific information to scanner 980 specifying a specific image to be projected onto surface 991 of object 990. Ex-1005 at 15:19-21; Ex-1013 ¶ 134. Orametrix describes that the image to be projected can be a digital image that is stored in memory by data processor 952. Ex-1005 at 17:11-19; Ex-1013 ¶ 134.

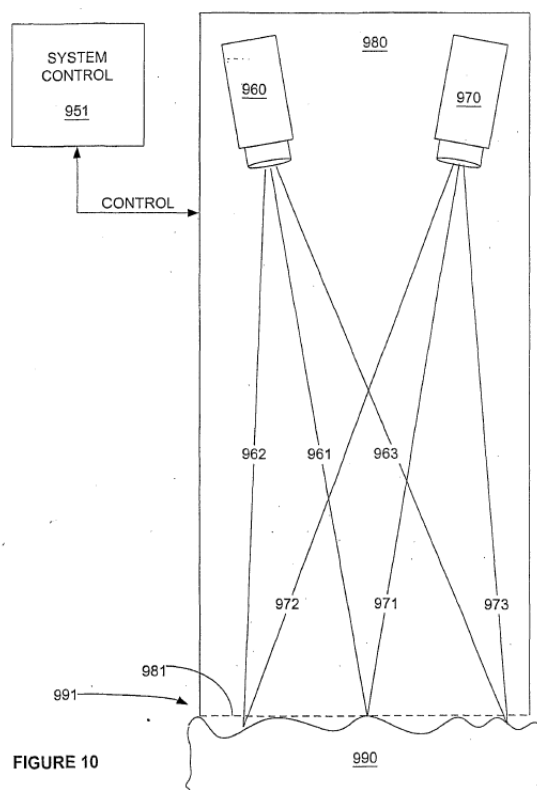
Orametrix further describes that in the scanning process, different patterns can be projected over different periods of time. Ex-1005 at 29:8-19; Figs. 16, 19, 23; Ex-1013 ¶ 134. Orametrix teaches that changing the projected patterns with different encoding and measuring features over time allows for more information to be obtained about the surface. Ex-1005 at 29:8-19; Figs. 16, 19, 23; Ex-1013 ¶ 134.

Faul also describes projecting a time-varying pattern of structured light to determine the shape of an object. *See* Ex-1004 at 4:36-53; Ex-1013 ¶ 135. Faul describes generating a time-varying pattern with a digital video projector. Ex-1004 at 4:25-53; 5:53-54; Ex-1013 ¶ 135. Faul discloses that the scanner includes a microprocessor and memory, Ex-1004 at 7:64-8:8, therefore, a POSITA would understand that this microprocessor would be utilized to implement the measurement process, including light source and camera control, as well as image processing. Ex-1013 ¶ 135.

A POSITA would have considered the digital image projection of Orametrix or Faul's projected pattern of structured light to be "a probe light with a plurality of configurations in the form of a time-varying illumination pattern," as claimed. Ex-1013 ¶ 136. Thus, Orametrix and Faul each teaches, and therefore renders this element of claim 14 obvious. Ex-1013 ¶ 136.

- e. **[Claim 14d]: “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 . . .”**

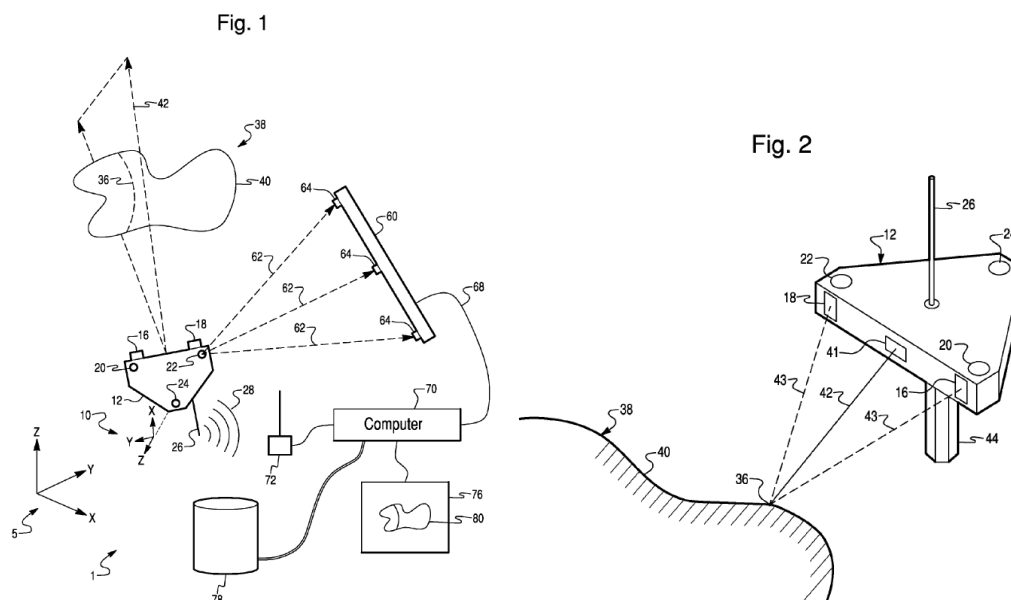
Figure 10 of Orametrix illustrates an optical system according to this claim element:



Ex-1013 ¶ 137. Orametrix shows projector 960 that transmits the patterned probe light beam along an optical path to the surface of object 990 thereby illuminating at least a part of the object with the time-varying illumination pattern. Ex-1005 at 16:6-13; Ex-1013 ¶ 138. The reflected light from the object is detected by viewing device

970. Ex-1005 at 16:6-13; Ex-1013 ¶ 138. Orametrix further describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. Ex-1005 at 30:7-8; Ex-1013 ¶ 138. The 2D image frames are then converted into 3D using conventional 3D imaging techniques. Ex-1005 at 30:8-12. *See also id.* at 75 (claim 4); Ex-1013 ¶ 138. A POSITA would understand that the scanner of Orametrix would have a tip for directing the scanning illumination towards a tooth in a mouth. *See supra* Sections IX.A.1.b and IX.A.9.b,

Faul also describes the elements of this claim limitation. Figures 1 and 2 of Faul illustrate the claimed optical system:



Ex-1013 ¶ 139. Faul describes a light source 41 projected on an optical path to a surface 36 from which reflected light is detected by at least one imaging sensor 16 or 18. Ex-1004 at 4:59-5:3; 8:45-9:25; 10:37-60; Ex-1013 ¶ 140. Faul describes the

two-dimensional video data based on the reflected time-varying pattern that are detected by 16 or 18 are used as the basis for a three-dimensional model of the scanned surface. Ex-1004 at 4:59-9:25; 7:11-29; Ex-1013 ¶ 140.

A POSITA would recognize that Orametrix's projector 960 and Faul's light source 41 are both "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," as recited by this claim element. Ex-1013 ¶ 141. Therefore, Orametrix and Faul render this claim element obvious. Ex-1013 ¶ 141.

f. [Claim 14e] "an optical system configured 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"

Orametrix describes that light projected by projector 960 reflected from the surface of object 990 is detected by viewing device 970. *See supra* Section IX.A.1.e; Ex-1013 ¶ 143. Faul describes that projected light from light source 41 is projected onto surface 36, the reflection of which is then detected by imaging sensor 16 or 18. Ex-1004 at 2:63-3:10; 4:59-5:3; 8:45-9:25; 10:37-50; Ex-1013 ¶ 144. A POSITA would recognize that Orametrix's viewing device and Faul's imaging sensors, in combination with the optical path of reflected light from surface, comprise "an optical system configure 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 . . .,” and therefore, Faul and Orametrix each renders this claim element obvious. Ex-1013 ¶ 145.

g. [Claim 14f]: “wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;”

Orametrix describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. *See supra* Section IX.A.1.g; Ex-1005 at 30:7-8; Ex-1013 ¶ 147. The 2D image frames are then converted into 3D using conventional 3D imaging techniques. Ex-1005 at 30:8-12. *See also id.* at 75 (claim 4); Ex-1013 ¶ 147. Faul describes that the two-dimensional video data based on the reflected time-varying pattern that are detected by 16 or 18 are used as the basis for a three-dimensional model of the scanned surface. Ex-1004 at 4:59-5:9; 5:38-41; 6:24-42; 7:11-29; Ex-1013 ¶ 148. A POSITA would recognize that Orametrix’s 2D image frame conversion and Faul’s two-dimensional video data analysis teach this claim element, and therefore each renders it obvious. Ex-1013 ¶ 149.

h. [Claim 14g]: “a hardware processor, located within the wireless intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times;”

Orametrix describes scanning the object surface with a time-varying pattern to determine shape information. *See supra* Section IX.A.1.c; Ex-1013 ¶ 150.

Furthermore, Orametrix describes changing the color of projected encoded features used for registration in multiframe scanning. Ex-1005 at 14:13-17; 25:11-26:5; Fig. 16; Ex-1013 ¶ 150. Orametrix also describes that photo data containing color information can be added to the digital data of the 3D virtual model of the anatomical structure. Ex-1005 at 64:6-15; Ex-1013 ¶ 150. Orametrix teaches that the measurement techniques may be implemented and executed by a hardware processor as part of the system. *See, e.g.*, Ex-1005 at 16:19-22; 64:6-15; 69:15-70:10; Fig. 46; Ex-1013 ¶ 150.

Faul also describes projecting a time-varying pattern to determine the shape of an object. *See* Ex-1004 at 4:36-53; Ex-1013 ¶ 151. Faul describes that the time-varying pattern is generated by a digital video projector. Ex-1004 at 4:25-53; 4:36-52; 5:53-54; Ex-1013 ¶ 151. Faul also describes measuring the color of the scanned surface. *See, e.g.*, Ex-1004 at 6:60-67; Ex-1013 ¶ 151. Faul also describes dynamically altering the color of the projected structured light. *See* Ex-1004 10:64-11:4; Ex-1013 ¶ 151. Faul discloses that the scanner includes a microprocessor, Ex-1004 at 7:49-8:8, and a POSITA would understand that this microprocessor would be utilized to implement the measurement process, including light source and camera control, as well as image processing. Ex-1013 ¶ 151.

Breton describes changing the wavelength of projected light from a controlled

monochromatic light source over time to illuminate the scanned object with different colors at different times to measure the color of the surface of the scanned object. *See, e.g.*, Ex-1003 at 6:62-7:20; Fig. 2; Ex-1013 ¶ 152. Breton describes that the wavelength of the light source needs to be stepped through a number of discrete spectral bands at a maximum bandwidth in order to achieve adequate spectral resolution for the spectral map that corresponds to the color of the tooth surface. *Id.*, Ex-1003 at 6:62-7:20; Fig. 2; Ex-1013 ¶ 152. Breton further discloses that the color of the teeth can be accurately measured using only three sampling bands in the red, blue, and green portions of the wavelength spectrum, and that limiting the spectral band scan reduce computation time. Ex-1003 at 8:24-36; Ex-1013 ¶ 152.

It would have been obvious to a POSITA to combine the wavelength scanning of the monochromatic light source of Breton with time-varying pattern projection of Orametrix or Faul to achieve an accurate color measurement. Ex-1013 ¶ 153. A POSITA would understand that the processors described by Orametrix and Faul would be configured to implement the color changing scheme as taught by Breton in the structured light projection in order to obtain sufficient spectral resolution to achieve an accurate color measurement of the scanned object surface. *Id.* Thus, Orametrix and Faul, further in view of Breton, teaches this claim element. *Id.*

- i. **[Claim 14h]: “a hardware processor, located within the wireless intraoral scanner, configured to: ... record images of the object with the different colors by recording different images by the at least one camera at the different times;”**

Orametrix and Faul teach recording images of the scanned surface at different times with different projected patterns. *See supra* Section X.A.1.i; Ex-1013 ¶ 154. For example, Orametrix describes that the data may be a composite of scans taken at different times. Ex-1005 at 57:7-16; Ex-1013 ¶ 154. Likewise, Faul describes assigning timestamps to each scanned image. Ex-1004 at 14:7-39 Ex-1013 ¶ 154. Faul also describes recording images of the object with different colors. Ex-1004 at 12:20-30; Fig. 4; Ex-1013 ¶ 154. A POSITA would be motivated to combine Breton’s color determination through wavelength scanning with either Orametrix or Faul in order to obtain sufficient spectral resolution in order to accurately measure the color of the scanned surface. *See supra* Section IX.A.1.h; Ex-1013 ¶ 154. A POSITA would understand that the wavelength scanning of this combination would necessarily require recording different images at different times reflecting the stepped wavelength changes. Ex-1013 ¶ 154. Thus, the combination of Orametrix or Faul in view of Breton teaches this claim element. *Id.* ¶¶154-55.

- j. **[Claim 14i]: “a hardware processor, located within the wireless intraoral scanner, configured to: ... process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and”**

Faul describes processing two-dimensional image data locally in the scanning device to reduce the amount of data that is required to be transmitted from the scanning device to a workstation. Ex-1004 at 4:59-5:51; 12:43-50; Ex-1013 ¶ 157. Faul describes that the subpixel coordinates of given points within the scanned 2D images are transformed into three-dimensional coordinates that are then transmitted. Ex-1004 at 12:27-32; Ex-1013 ¶ 157. Furthermore, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. *See supra* Section IX.A.1.h; Ex-1013 ¶ 157. A POSITA would implement the local processing taught by Faul in the combined scanning system of Orametrix, Faul, and Breton to reduce the amount of data required to be transmitted wirelessly and increase overall processing speed for rendering the three-dimensional model of the scanned surface. Ex-1013 ¶ 157. Therefore, Orametrix in view of Faul renders this claim element obvious. *Id.* ¶¶ 157-58.

- k. **[Claim 14j]: “a hardware processor, located within the wireless intraoral scanner, configured to: ... 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.”**

Faul describes processing two-dimensional image data locally in the scanning device to reduce the amount of data that is required to be transmitted from the scanning device to a workstation. Ex-1004 at 4:59-5:51; 12:43-50; Ex-1013 ¶ 160. Faul teaches that the subpixel coordinates of given points within the scanned 2D images are transformed into three-dimensional coordinates that are then transmitted. Ex-1004 at 12:27-32; Ex-1013 ¶ 161. Faul specifically describes that this local processing significantly reduces the amount of transmitted geometric and color data, as compared to conventional transmission. Ex-1004 at 12:43-50; Ex-1013 ¶ 161. A POSITA would understand that this locally processed data is transmitted at a reduced data rate compared with what would be required to transmit the raw data before local processing. Furthermore, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. *See supra* Section IX.A.1.h; Ex-1013 ¶ 160. A POSITA would implement the local processing taught by Faul in the combined scanning system of Orametrix, Faul, and Breton to reduce the amount of data required to be transmitted wirelessly and increase overall processing speed for rendering the three-dimensional model of the scanned surface. Ex-1013 ¶ 160.

Therefore, Orametrix in view of Faul renders this claim element obvious. *Id.* ¶¶ 160-61.

10. Claim 15 Is Rendered Obvious by Orametrix in view of Faul, Breton, and Knighton

- a. **[Claim 15]: “The handheld intraoral scanner of claim 14, wherein the hardware processor is further configured to process the raw 3D data into data for the 3D geometry in real time.”**

Orametrix describes allowing for real-time viewing of a three-dimensional image of the scanned object. Ex-1005 at 34:12-15; Ex-1013 ¶ 163. Faul also describes rendering the geometry of a three-dimensional object in real-time. Ex-1004 at 8:56-60; Ex-1013 ¶ 163. Therefore, Orametrix and Faul render claim 15 obvious. Ex-1013 ¶¶ 163-64.

11. Claim 16 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. **[Claim 16]: “The handheld intraoral scanner of claim 14, further comprising: one or more motion sensors located on the intraoral scanner to measure three-dimensional motion of the intraoral scanner.”**

Orametrix describes the direct measurement of anatomical structures, including teeth. Ex-1005 at 56:11-20; Ex-1013 ¶ 166. Orametrix describes wirelessly communicating scanning data from the system to a client. Ex-1005 at 58:21-59:13; Fig. 44; Ex-1013 ¶ 166. This client may be, for example, design device 4415 at facility 4442, which is a workstation located remotely from scanner 4401.

Ex-1005; Ex-1013 ¶ 166. The scan data may be a dental structure, and Orametrix describes an example where the scanner may be performed at home by a user for monitoring the progress of a treatment plan. Ex-1005 at 58:1-14; Ex-1013 ¶ 166. Orametrix also describes an embodiment where probable movement of the scanner in the X, Y, and Z directions is determined. *See, e.g.*, Ex-1005 at 37:11-38:13; Ex-1013 ¶ 166. This movement data is used in the modeling process to perform registration between image frames. Ex-1005 at 38:18-41:9; Ex-1013 ¶ 166. Given this disclosure, a POSITA would understand that Orametrix's scanner would be wireless and communicating data wirelessly for remote processing. Ex-1013 ¶ 166.

Faul explicitly teaches the advantages of a wireless handheld scanner for obtaining scanning data of 3D shapes in that it is unencumbered by a cable or mechanical linkage. *See, e.g.*, Ex-1004 at 2:36-39; Ex-1013 ¶ 167. Faul also teaches that the position of the scanner can be tracked by any sort of 3D tracking system, including non-optical tracking systems. *See, e.g.*, Ex-1004 at 8:45-60; Ex-1013 ¶ 167. This position data is used to generate a set of 3D surface point coordinates that are used to model the scanned objects surface in 3D. *See, e.g.*, Ex-1004 at 3:11-24; 9:27-60; Ex-1013 ¶ 167.

Knighton teaches a wireless, handheld optical scanning system that includes position tracking sensors in the scanner itself that may include gyroscopes, GPS

devices, altimeters, and accelerometers. *See supra* Section VIII.A.4; Ex-1013 ¶ 168; *see also* Ex-1008 at [0044]; *see also* Ex-1008 at [0033], [0045] (describing wireless configurations). Knighton further discloses that position and movement data may be generated by these sensors. Ex-1008 at [0044]; Ex-1013 ¶ 169. Data from the position tracking sensors is used to correlate a scanned depth map to a three-dimensional representation of the surface to be scanned. Ex-1008 at [0080], [0082]; Ex-1013 ¶ 168.

It would have been obvious to a POSITA to configure the scanner of Orametrix with the wireless configurations taught by Faul because Orametrix already contemplates the wireless transmission of data, and Faul teaches that making the handheld scanning unit wireless allows the user to scan objects without mechanical linkage or cables, which would facilitate easier direct measurements of teeth in a mouth. Ex-1013 ¶ 169.

Furthermore, it would have been obvious to include the non-optical position tracking sensors, as taught by Knighton in the wireless scanner of Orametrix in combination with Faul, in order to obtain accurate position and movement data to be used in the three-dimensional modeling of the scanned surface. Ex-1013 ¶ 170. Therefore, Orametrix in view of Faul and Knighton renders claim 16 obvious. *Id.* at ¶ 171.

12. Claim 18 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. [Claim 18]: “The handheld intraoral scanner according to claim 16, wherein the hardware processor is further configured to: output data from the one or more motion sensors for stitching and/or registering partial scans to one another.”**

Orametrix describes using probable scanner position for registering and stitching partial scans of the object to create an integrated surface map of the object. *See supra* Sections VIII.A.1, IX.A.1.h; Ex-1013 ¶ 173. Furthermore, Orametrix in combination with Faul and Knighton teaches using motion sensors to track the motion and position of the scanner, and that the position and motion data is used in the calculation of the three-dimensional modeling of the scanned surface. *See supra* Section IX.A.1.h. Therefore, Orametrix in view of Faul and Knighton renders claim 18 obvious. Ex-1013 ¶ 174.

13. Claim 19 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. [Claim 19]: “The handheld intraoral scanner according to claim 14, wherein the light source further comprises at least three monochromatic light sources configured to provide the different colors.”**

Orametrix in view of Faul and Breton teaches changing colors of the projected structured light pattern. *See Supra* Section IX.A.1.a; Ex-1013 ¶ 176. Breton further describes that illumination assembly 14 contains a number of light sources that are

not pictured. Ex-1003 at 3:53-56; 4:20-26; Ex-1013 ¶ 176. Breton also teaches the advantages of limiting the color band analysis to the red, blue, and green color bands to conserve processing resources. Ex-1003 at 11:21-27; Ex-1013 ¶ 176. A POSITA would have understood that the multiple light sources of Breton to include three monochromatic light sources to provide the red, blue, and green wavelength bands for scanning the object surface. Thus, Orametrix in view of Faul and Breton renders claim 19 obvious. Ex-1013 ¶ 178.

14. Claim 20 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. [Claim 20]: “The handheld intraoral scanner according to claim 14, wherein the hardware processor is further configured to selectively switch the color of the probe light by switching on and off the at least three monochromatic light sources.”**

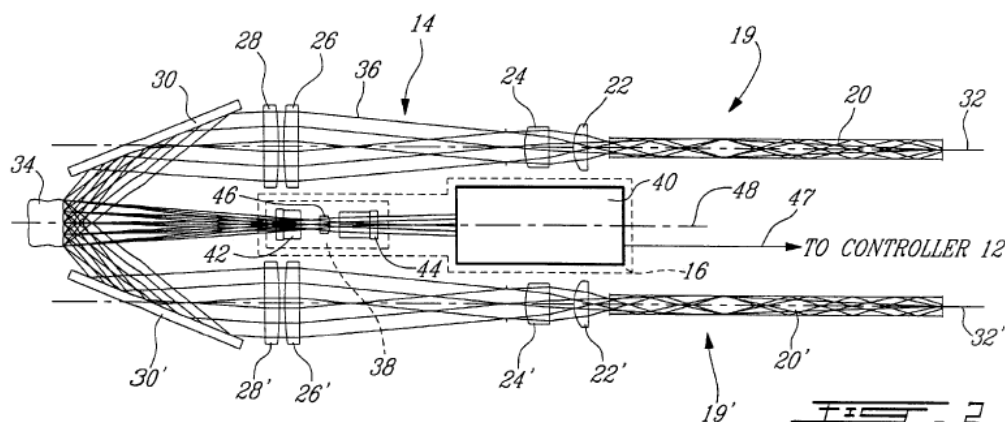
Breton describes an illuminator assembly comprised of multiple light sources. *See Supra* Sections VIII.A.3, IX.A.1.i, IX.A.13; Ex-1013 ¶ 179. Breton describes an illuminator assembly comprised of multiple light sources. Breton also teaches changing the wavelength of the light used to scan the tooth surface. Ex-1003 at 6:62-11; Ex-1013 ¶ 179. A POSITA would selectively switch the three monochromatic light sources in the combination of Orametrix, Faul, and Breton to obtain separate measurements of the red, blue, and green spectral bandwidths, and therefore obtain an accurate color measurement of the tooth surface while conserving computational

resources. Ex-1013 ¶ 179. Thus, Orametrix in view of Faul further in view of Breton renders claim 20 obvious. Ex-1013 ¶ 180.

15. Claim 22 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. [Claim 22]: “The handheld intraoral scanner according to claim 14, wherein the optical system is further configured to direct the probe light towards the object in a direction substantially parallel with the longitudinal axis of the tip, and wherein the tip further comprises a single reflective mirror that is configured to reflect the probe light towards the object.”

As illustrated in Figure 2 of Breton, the measurement illumination is directed towards the tooth being measured in a direction parallel with the longitudinal axis of the device:



Ex-1003 at Fig. 2; Ex-1013 at ¶ 182. Breton also describes directing the measurement illumination from integrator rod 20 towards tooth surface 34 using

mirror 30. Ex-1003 at 4:1-26; Ex-1013 at ¶ 183. Breton teaches that this configuration minimizes specular reflection. Ex-1003 at 4:19-26; Ex-1013 at ¶ 183. Breton also teaches that other illumination and mirror configurations could be utilized. Ex-1003 at 4:19-26; Ex-1013 at ¶ 183. A POSITA would be motivated to include a single mirror, as taught by Breton, in the tip of the scanner of the combination of Orametrix and Faul in order to accurately scan the surface to be measured and avoid specular reflections. Ex-1013 at ¶ 183. Thus, Orametrix in view of Faul further in view of Breton renders claim 22 obvious. Ex-1013 ¶ 184.

16. Claim 26 Is Rendered Obvious by Orametrix In View of Faul, Breton, and Knighton

- a. **[Claim 26 pre]: “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:”**

The District Court determined that the preamble of claim 26 is not limiting. *See Supra* Section VII.A. Nevertheless, Orametrix teaches a scanning system for determining the shape and color of tooth in an oral cavity. *See, e.g.*, Ex-1005 at 1:15-22; 15:19-21; 30:15-23; 31:11-33:7; 66:6-15, Figs. 10, 27, 28, 29; Ex-1013 ¶ 186. Orametrix further teaches that the scanner would be held by a user, for example, a user in a home setting. *See, e.g.*, Ex-1005 at 58:1-14; Ex-1013 ¶ 186. Thus, Orametrix renders the preamble of claim 26 obvious. *See* Ex-1013 ¶ 186.

b. [Claim 26a]: “a tip configured to be inserted into the oral cavity;”

Orametrix describes a scanning device 4401 that shows a tip, as illustrated in

Figure 44:

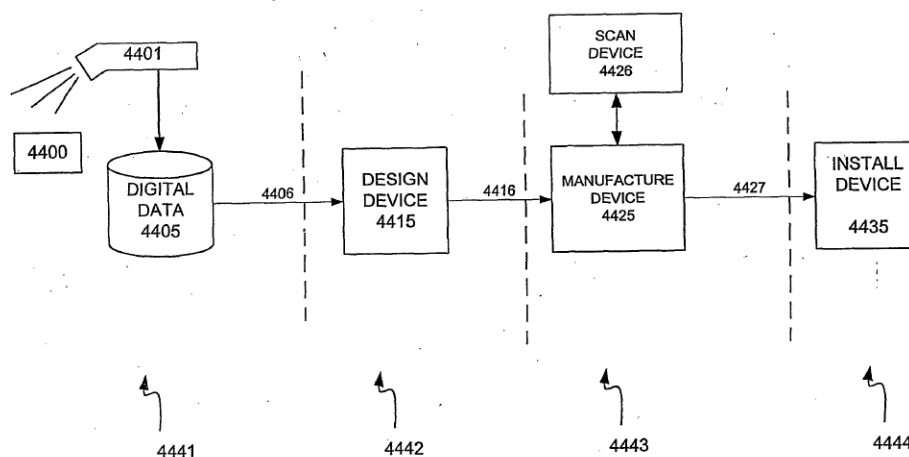


FIGURE 44

Ex-1005 at Fig. 44; Ex-1013 ¶ 187. Orametrix further discloses that the anatomical structure, such as a tooth, can be scanned directly by scanner 4401. Ex-1005 at 56:11-20; *see also id.* at 31:11-19; Fig. 27 (describing scanning a tooth surface); Ex-1013 ¶ 188. The scanner illustrated in Figure 44, in combination with the description of direct scanning of anatomical structures, teaches the claimed “tip” limitation. Ex-1013 ¶ 188. Furthermore, a POSITA would understand that in order to facilitate direct scanning of an anatomical structure, such as a tooth in a mouth, a housing that includes a tip would be needed to protect the scanning optics from damage or debris.

Id. Thus, Orametrix renders this element of claim 26 obvious. Ex-1013 ¶ 189.

c. [Claim 26b]: “at least one camera accommodating an array of sensor elements;”

Orametrix teaches a camera or viewer for capturing the reflected projected structured light pattern from an object to be scanned, including a CCD (charge coupled device). *See* Ex-1005 at 4:3-10; 16:6-13; 34:4-6; Ex-1013 ¶ 190. A POSITA would understand the camera/viewer of Orametrix would necessarily include an array of sensor elements. Ex-1013 ¶ 190. Thus, Orametrix renders this element of claim 26 obvious. Ex-1013 ¶ 191.

d. [Claim 26c]: “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;”

Orametrix describes system controller 951 which includes data processor 952, projection image representation 953, projector controller 954, and viewer controller 955. Ex-1005 at 16:19-22; Figs. 10, 11; Ex-1013 ¶ 192. System controller 951 provides specific information to scanner 980 specifying a specific image to be projected onto surface 991 of object 990. Ex-1005 at 15:19-21; Ex-1013 ¶ 192. Orametrix describes that the image to be projected can be a digital image that is stored in memory by data processor 952. Ex-1005 at 17:11-19; Ex-1013 ¶ 192. Orametrix further describes that in the scanning process, different patterns can be

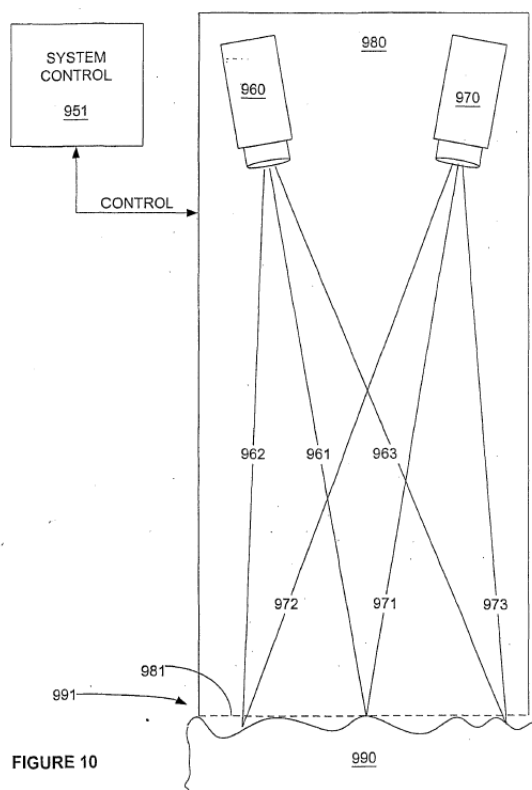
projected over different periods of time. Ex-1005 at 29:8-19; Figs. 16, 19, 23; Ex-1013 ¶ 192. Orametrix teaches that changing the projected patterns with different encoding and measuring features over time allows for more information to be obtained about the surface. *Id.*

Faul also describes projecting a time-varying pattern of structured light to determine the shape of an object. *See* Ex-1004 at 4:36-53; Ex-1013 ¶ 194. Faul describes generating the time-varying pattern with a digital video projector. Ex-1004 at 4:25-53; 5:52-5:74; Ex-1013 ¶ 193. Faul discloses that the scanner includes a microprocessor and memory. Ex-1004 at 7:64-8:8; Ex-1013 ¶ 193. A POSITA would understand that this microprocessor would be utilized to implement the measurement process, including light source and camera control, as well as image processing. Ex-1013 ¶ 193.

A POSITA would have considered the digital image projection of Orametrix or Faul's projected pattern of structured light to be "a probe light with a plurality of configurations in the form of a time-varying illumination pattern," as claimed. Ex-1013 ¶ 194. Thus, Orametrix and Faul render obvious this element of claim 26. *Id.*

- e. **[Claim 26d]: “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 . . .;”**

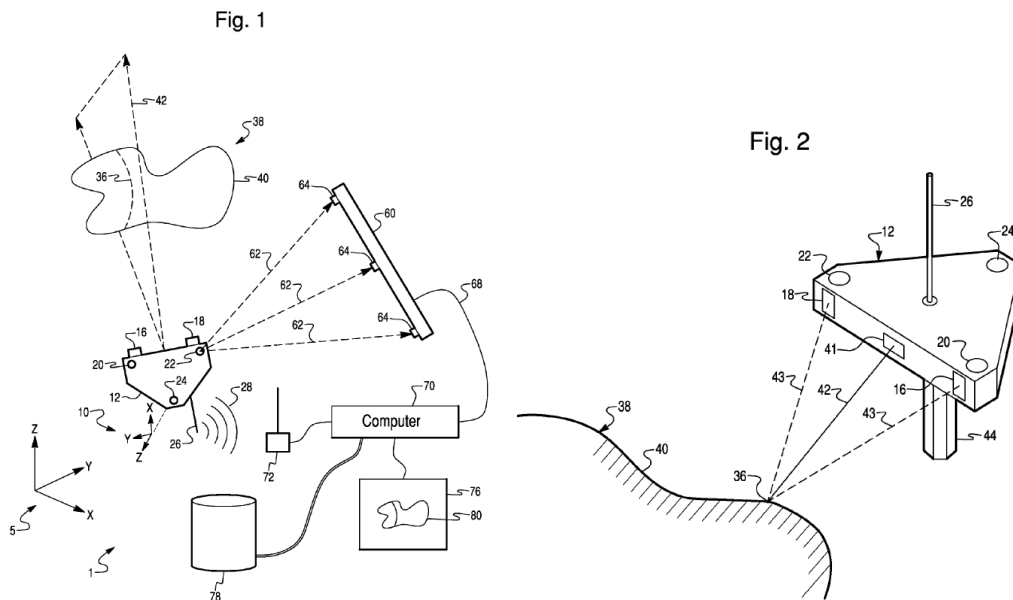
Figure 10 of Orametrix illustrates an optical system according to this claim element:



Ex-1005 at Fig. 10; Ex-1013 ¶ 195. Orametrix shows projector 960 that transmits the patterned probe light beam along an optical path to the surface of object 990 thereby illuminating at least a part of the object with the time-varying illumination pattern. Ex-1005 at 16:6-13; Ex-1013 ¶ 196. The reflected light from the object is

detected by viewing device 970. Ex-1005 at 16:6-13; Ex-1013 ¶ 196. Orametrix further describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. Ex-1005 at 30:7-8; Ex-1013 ¶ 196. The 2D image frames are then converted into 3D using conventional 3D imaging techniques. Ex-1005 at 30:8-12; *see also id.* at 75 (claim 4); Ex-1013 ¶ 197. A POSITA would understand that the scanner of Orametrix would have a tip for directing the scanning illumination towards a tooth in a mouth. *See supra* Sections IX.A.1.b and IX.A.9.b.

Figures 1 and 2 of Faul illustrate the claimed optical system:



Ex-1004 at Figs. 1-2; Ex-1013 ¶ 197. As illustrated above, Faul describes a light source 41 projected on an optical path to a surface 36 from which reflected light is detected by at least one imaging sensor 16 or 18. Ex-1004 at 4:59-5:3; 8:45-9:25;

10:37-60; Ex-1013 ¶ 198. Faul describes the two-dimensional video data based on the reflected time-varying pattern that are detected by 16 or 18 are used as the basis for a three-dimensional model of the scanned surface. Ex-1004 at 4:59-9:25; 7:11-29; Ex-1013 ¶ 198.

A POSITA would recognize that Orametrix's projector 960 and Faul's light source 41 are both "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," as recited by this claim element. Ex-1013 ¶ 199. Thus, Orametrix and Faul each renders this element of claim 26 obvious. *Id.*

f. [Claim 26e]: "an optical system configured 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,"

Orametrix describes that light projected by projector 960 reflected from the surface of object 990 is detected by viewing device 970. *See Supra* Section IX.A.1.f; Ex-1005 at 16:6-13; Fig. 10; Ex-1013 ¶ 201. Faul describes that projected light from light source 41 is projected onto surface 36, the reflection of which is then detected by imaging sensor 16 or 18. Ex-1005 at 2:63-3:10; 4:59-5:3; 8:45-9:25; 10:37-60; Ex-1013 ¶ 202. A POSITA would recognize that Orametrix's viewing device and Faul's imaging sensors, in combination with the optical path of reflected light from

surface, comprise “an optical system configured 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 . . .,” as recited in this claim element. Ex-1013 ¶ 203. Thus, Orametrix and Faul each renders this element of claim 26 obvious. *Id.*

g. [Claim 26f]: “wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;”

Orametrix describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. *See Supra* Section IX.A.1.e; Ex-1005 at 30:7-8; Ex-1013 ¶ 205. The 2D image frames are then converted into 3D using conventional 3D imaging techniques. Ex-1005 at 30:8-12; *see also id.* at 75 (claim 4); Ex-1013 ¶ 205. Faul describes the two-dimensional video data based on the reflected time-varying pattern that are detected by 16 or 18 are used as the basis for a three-dimensional model of the scanned surface. Ex-1004 at 4:59-5:9; 5:38-41; 6:24-42; 7:11-29; Ex-1013 ¶ 206.

A POSITA would recognize that Orametrix’s 2D image frame conversion and Faul’s two-dimensional video data analysis teach that “the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern,” as recited in this claim element. Ex-1013 ¶ 207. Thus, Orametrix and Faul each renders this element of claim 26 obvious. *Id.*

h. [Claim 26g]: “one or more motion sensors located on the intraoral scanner to measure three-dimensional motion of the intraoral scanner; and”

Orametrix describes the direct measurement of anatomical structures, including teeth. Ex-1005 at 31:11-19; 56:11-20; Ex-1013 ¶ 208. Orametrix describes wirelessly communicating scanning data from the system to a client. Ex-1005 at 58:21-59:13; Fig. 44; Ex-1013 ¶ 208. This client may be, for example, design device 4415 at facility 4442, which is a workstation located remotely from scanner 4401. Ex-1005 at 58:21-59:13; Fig. 44. *See also id.* at 62:19-21; 63:11-18; Ex-1013 ¶ 208. The scan data may be a dental structure, and Orametrix describes an example where the scanner may be performed at home by a user for monitoring the progress of a treatment plan. Ex-1005 at 58:1-14; Ex-1013 ¶ 208. Orametrix also describes an embodiment where probable movement of the scanner in the X, Y, and Z directions is determined. *See, e.g.,* Ex-1005 at 37:11-38:13; Ex-1013 ¶ 208. This movement data is used in the modeling process to perform registration between image frames. Ex-1005 at 38:18-41:9; Ex-1013 ¶ 208. A POSITA would understand that Orametrix’s scanner would be wireless and communicating data wirelessly for remote processing. Ex-1013 ¶ 208.

Faul explicitly teaches the advantages of a wireless handheld scanner for obtaining scanning data of 3D shapes in that it is unencumbered by a cable or

mechanical linkage. *See, e.g.*, Ex-1004 at 2:36-39; 3:44-45; 6:43-50; Ex-1013 ¶ 209. Faul also discloses that the position of the scanner can be tracked by any sort of 3D tracking system, including non-optical tracking systems. *See, e.g.*, Ex-1004 at 8:45-60; Ex-1013 ¶ 209. This position data is used to generate a set of 3D surface point coordinates that are used to model the scanned objects surface in 3D. *See, e.g.*, Ex-1004 at 3:11-24; 9:27-60; Ex-1013 ¶ 209.

Knighton teaches a wireless, handheld optical scanning system that includes position tracking sensors in the scanner itself that may include gyroscopes, GPS devices, altimeters, and accelerometers. *See Supra* Section VIII.A.4; *see, e.g.*, Ex-1008 at [0044]. *See also id.* at [0033], [0045]; Ex-1013 ¶ 210. Knighton further discloses that position and movement data may be generated by these sensors. Ex-1008 at [0044]; Ex-1013 ¶ 210. Data from the position tracking sensors is used to correlate a scanned depth map to a three-dimensional representation of the surface to be scanned. Ex-1008 at [0080], [0082]; Ex-1013 ¶ 210.

It would have been obvious to a POSITA to configure the scanner of Orametrix with the wireless configurations taught by Faul because Orametrix already contemplates the wireless transmission of data, and Faul teaches that making the handheld scanning unit wireless allows the user to scan objects without mechanical linkage or cables, which would facilitate easier direct measurements of

teeth in a mouth. Ex-1013 ¶ 211. Furthermore, it would have been obvious to include the non-optical position tracking sensors, as taught by Knighton in the wireless scanner of Orametrix in combination with Faul, in order to obtain accurate position and movement data to be used in the three-dimensional modeling of the scanned surface. *Id.* at ¶ 212. Thus, Orametrix in view of Faul and Knighton render obvious this element of claim 26. *Id.* at ¶ 213.

- i. **[Claim 26h]: “a hardware processor, located within the wireless intraoral scanner, configured to: selectively switch a color of the probe light to illuminate the object with different colors at different times; and”**

Orametrix describes scanning the object surface with a time-varying pattern to determine shape information. *See Supra* Section IX.A.1.c; Ex-1013 ¶ 214. Furthermore, Orametrix describes changing the color of projected encoded features used for registration in multi-frame scanning. Ex-1005 at 14:13-17; 25:11-26:5; Fig. 16; Ex-1013 ¶ 214. Orametrix also describes that photo data containing color information can be added to the digital data of the 3D virtual model of the anatomical structure. Ex-1005 at 64:6-15; Ex-1013 ¶ 214. Orametrix teaches that the measurement techniques may be implemented and executed by a hardware processor as part of the system. *See, e.g.*, Ex-1005 at 16:19-22; 64:6-15; 69:15-70:10; Fig. 46; Ex-1013 ¶ 214.

Faul also describes projecting a time-varying pattern to determine the shape of an object. *See* Ex-1004 at 4:36-53; Ex-1013 ¶ 215. Faul describes that the time-varying pattern can be generated by a digital video projector. Ex-1004 at 4:25-53; 4:36-52; 5:52-5:74; Ex-1013 ¶ 215. Faul also describes measuring the color of the scanned surface. *See, e.g.*, Ex-1004 at 6:60-67; Ex-1013 ¶ 215. Faul also describes dynamically altering the color of the projected structured light. *See* Ex-1004 10:64-11:4; Ex-1013 ¶ 215. Faul discloses that the scanner includes a microprocessor, Ex-1004 at 7:49-8:8; Ex-1013 ¶ 215. A POSITA would understand that this microprocessor would be utilized to implement the measurement process, including light source and camera control, as well as image processing. Ex-1013 ¶ 215.

Breton describes changing the wavelength of projected light from a controlled monochromatic light source over time to illuminate the scanned object with different colors at different times to measure the color of the surface of the scanned object. *See, e.g.*, Ex-1003 at 6:62-7:20; Fig. 2; Ex-1013 ¶ 216. Breton describes that the wavelength of the light source needs to be stepped through a number of discrete spectral bands at a maximum bandwidth in order to achieve adequate spectral resolution for the spectral map that corresponds to the color of the tooth surface. Ex-1003 at 6:62-7:20; Fig. 2; Ex-1013 ¶ 216. Breton further discloses that the color of the teeth can be accurately measured using only three sampling bands in the red,

blue, and green portions of the wavelength spectrum, and that limiting the spectral bands can reduce computation time. Ex-1003 at 8:24-36; Ex-1013 ¶ 216.

It would have been obvious to a POSITA to combine the wavelength scanning of the monochromatic light source of Breton with time-varying pattern projection of Orametrix or Faul in order to measure the color of the scanned surface at an adequate spectral resolution, and therefore achieve an accurate color measurement. Ex-1013 ¶ 217. The processor of Orametrix is already configured to change the color of projected encoding features, and is configured to introduce color information from photo data into the three-dimensional model. *Id.* Faul itself teaches color measurement and suggests dynamically changing the color of the projected time-varying structured light. *Id.* A POSITA would understand that the processors described by Orametrix and Faul would be configured to implement the color changing scheme as taught by Breton in the structured light projection in order to obtain sufficient spectral resolution to achieve an accurate color measurement of the scanned object surface. *Id.* Thus, Orametrix or Faul, further in view of Breton, teaches this element of claim 26. *Id.*

- j. **[Claim 26i]: “a hardware processor configured to: . . . record images of the object with the different colors by recording different images by the at least one camera at the different times.”**

Both Orametrix and Faul teach recording images of the scanned surface at

different times with different projected patterns. *See Supra* Section IX.A.1.c; Ex-1013 ¶ 218. Orametrix describes that the data may be a composite of scans taken at different times. Ex-1005 at 57:7-16; Ex-1013 ¶ 218. Likewise, Faul describes assigning timestamps to each scanned image. Ex-1004 at 14:7-39; Ex-1013 ¶ 218. Faul also describes recording images of the object with different colors. Ex-1004 at 12:20-30; Fig. 4 (describing data format 403 that includes RGB color intensities for each point in the image); Ex-1013 ¶ 218. A POSITA would be motivated to combine Breton's color determination through wavelength scanning with either Orametrix or Faul in order to obtain sufficient spectral resolution in order to accurately measure the color of the scanned surface. *See Supra* Section IX.A.1.h; Ex-1013 ¶ 218. A POSITA would understand that the wavelength scanning of this combination would necessarily require recording different images at different times reflecting the stepped wavelength changes. Ex-1013 ¶ 218. Thus, Orametrix or Faul in view of Breton renders this element of claim 26 obvious. *Id.* at ¶ 219.

17. Claim 28 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. **[Claim 28]: “The handheld intraoral scanner according to claim 26, wherein the hardware processor is further configured to: output data from the one or more motion sensors for stitching and/or registering partial scans to one another.”**

Orametrix describes using probable scanner position for registering and

stitching partial scans of the object to create an integrated surface map of the object. *See Supra* Sections VIII.A.1, IX.A; Ex-1013 ¶ 221. Furthermore, Orametrix in combination with Faul and Knighton teaches using motion sensors to track the motion and position of the scanner, and that the position and motion data is used in the calculation of the three-dimensional modeling of the scanned surface. *See Supra* Section IX.A.1.h; Ex-1013 ¶ 221. Thus, Orametrix in view of Faul and Knighton renders obvious claim 28. *Id.* at ¶ 222.

18. Claim 29 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton

- a. **[Claim 29]: “The handheld intraoral scanner according to claim 26, wherein the intraoral scanner is wireless and the hardware processor is further configured to: 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.”**

Faul describes processing two-dimensional image data locally in the scanning device to reduce the amount of data that is required to be transmitted from the scanning device to a workstation. Ex-1004 at 4:59-5:51; 12:43-50; Ex-1013 ¶ 225. Faul describes that subpixel coordinates of given points on the scanned 2D images are transformed into three-dimensional coordinates that are then transmitted. Ex-1004 at 12:27-32; Ex-1013 ¶ 225. Faul specifically describes this local processing

as significantly reducing the amount of transmitted geometric and color data, as compared to conventional transmission. Ex-1004 at 12:43-50; Ex-1013 ¶ 225. A POSITA would understand that this locally processed data is transmitted at a reduced data rate compared with what would be required to transmit the raw data before local processing. Ex-1013 ¶ 225. Furthermore, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. *See Supra* Section IX.A.1.h; Ex-1004 ¶ 225. A POSITA would implement the local processing taught by Faul in the combined scanning system of Orametrix, Faul, and Breton to reduce the amount of data required to be transmitted wirelessly and increase overall processing speed for rendering the three-dimensional model of the scanned surface. Ex-1013 ¶ 225. Thus, Orametrix in view of Faul renders claim 29 obvious. *Id.* at ¶ 226.

X. INSTITUTION SHOULD NOT BE DISCRETIONARILY DENIED

A. Denial Under 35 U.S.C. § 314(a) Would Be Improper

Petitioner hereby stipulates that, should the Petition be granted, it will not pursue in the District Court 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) (precedential as to § II.A). Under the June 21, 2022 Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation, the Director has stated “the

PTAB will not discretionarily deny institution of an IPR” in view of such a stipulation. Interim Procedure at 7; *id.* at 3 and n.3 (discussing *Sotera*).

Accordingly, Petitioner’s stipulation is dispositive in establishing that institution should not be denied pursuant to 35 U.S.C. § 314(a).

B. Denial under 35 U.S.C. § 325(d) Is Improper

“In evaluating arguments under § 325(d), [the PTAB] use[s] a two-part framework: (1) whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office; and (2) if either condition of the first part of the framework is satisfied, whether the petition has demonstrated that the Office erred in a manner material to the patentability of challenged claims.” *The Data Co. Techs., Inc. v. Bright Data Ltd.*, IPR2022-00145, Paper 12 at 15 (PTAB June 1, 2022) (citation omitted).

Knighton was presented in IPR2023-00411, which was filed against the ’667 patent, but for which institution was denied. The Board has stressed that such decisions on institution are preliminary and therefore not sufficient to satisfy the relevant analysis under § 325(d). *See Google LLC v. Uniloc 2017 LLC*, IPR2019-01584, Paper 7, at 11 (PTAB March 24, 2020).

Petitioner’s limited reliance on Knighton in this Petition differs from that of

IPR2023-00411. The Board did not identify Knighton as a factor in denying institution – and focused instead on Babayoff and Zhang’s incompatibility. *See Dental Imaging Techs. Corp. v. 3Shape A/S, IPR2023-00411*, Paper 8, at 24-25 (PTAB July 3, 2023).

While Knighton and Orametrix are cited on the face of the ’667 patent, they were not discussed or relied on during examination. The Examiner did not reject any claims over these references. In sum, no substantially similar arguments or combination of references to those in this Petition were presented to the Office during examination.

These facts do not support denial under § 325(d). Indeed, “[t]he Board has consistently declined exercising its discretion under Section 325(d) when the only fact a Patent Owner can point to is that a reference was disclosed to the Examiner during the prosecution.” *Amgen, Inc. v. Alexion Pharms., Inc.*, IPR2019-00739, Paper 15, at 62 (PTAB Aug. 30, 2019). This is particularly true where “the Examiner did not make any prior art rejections during prosecution.” *Navistar, Inc. v. Fatigue Fracture Tech., LLC*, IPR2018-00853, Paper 13, at 17-18 (PTAB Sept. 12, 2018).

Even if the first prong of the *Advanced Bionics* framework is satisfied, under the second prong, the Office erred failing to discuss, or reject the claims over, the teachings of Orametrix or Knighton during examination. Since no prior art rejection

was based on these references, the *Becton, Dickinson* factors disfavor discretionary denial under § 325(d). *See Amgen*, IPR2019-00739, Paper 15, at 60-63 (discussing *Becton, Dickinson* factors).

XI. MANDATORY NOTICES

A. Real Parties in Interest—37 C.F.R. § 42.8(b)(1)

The following entities are real parties in interest to this proceeding:

- Medit Corporation
- Medit USA
- Crown Jade Co., Ltd.
- Digital Dentistry Solution Holdings, Inc.

No other parties had access to or control over this Petition, and no other parties funded this Petition.

B. Related Matters—37 C.F.R. § 42.8(b)(2)

To the best of Petitioner's knowledge, the '667 patent has been or is involved in the following cases:

- *Dental Imaging Technologies Corporation d/b/a/ DEXIS v. 3Shape A/S* IPR2023-00411 (PTAB). This case is no longer ongoing.
- *3Shape A/S v. Carestream Dental, LLC*, 1:22-cv-01829 (N.D. Ga.). This case is ongoing.

- *3Shape A/S v. Medit Corporation*, 6:22-cv-00443 (W.D. Tex.). This case is ongoing.

Petitioner is not aware of any other matters involving the '667 patent.

C. Lead and Back-Up Counsel—37 C.F.R. § 42.8(b)(3)

Petitioner provides the following designation of counsel.

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

Please address all correspondence and service to the address listed above.

Petitioner consents to electronic service by email at Bracewell-IP@bracewell.com.

XII. CONCLUSION

The prior art references cited herein demonstrate that the challenged claims of the '667 patent are anticipated and obvious. Petitioner thus requests that the PTAB grant this Petition, institute IPR, and cancel the challenged claims.

Respectfully Submitted,

Dated: August 18, 2023

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CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24, the undersigned certifies that the foregoing Petition for *Inter Partes* Review contains 13,987 words excluding the caption, table of contents, table of authorities, table of exhibits, claim listing, mandatory notices, certificate of service, and certificate of word count. Petitioner has relied on the word count feature of the word processing system used to create this paper in making this certification.

Dated: August 18, 2023

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CERTIFICATE OF SERVICE

I hereby certify that on August 18, 2023, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review, associated exhibits, and power of attorney to be served via overnight courier upon the following counsel of record for Patent Owner per 37 CFR §§ 42.105(a) and 42.205(a).

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I further certify that I served courtesy copies of the foregoing documents via electronic mail on August 18, 2023, upon Patent Owner's counsel of record as follows:

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