

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

DECLARATION OF RONGGUANG LIANG, PhD.

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	QUALIFICATIONS	1
	A. Industry Experience.....	3
	B. Academic Experience.....	3
	C. Other Relevant Experience.....	4
III.	MATERIALS CONSIDERED	4
IV.	TECHNOLOGY BACKGROUND	6
V.	OVERVIEW OF THE '667 PATENT.....	8
	A. Specification of the '667 Patent	8
	B. Prosecution History	10
VI.	LEGAL PRINCIPLES USED IN ANALYSIS	11
	A. Prior Art.....	11
	B. Anticipation	12
	C. Obviousness.....	12
	D. Claim Construction.....	16
VII.	LEVEL OF ORDINARY SKILL IN THE ART	18
VIII.	CLAIM CONSTRUCTION.....	19
	A. The Preambles to Independent Claims 1, 14, and 26 Are Not Limiting	19
	B. “data for the 3D geometry” (Claims 8, 15).....	20
IX.	OVERVIEW OF THE PRIOR ART	20
	A. Orametrix.....	20
	B. Faul	24
	C. Breton	26
	D. Knighton.....	27
X.	THE PRIOR ART RENDERS ALL OF THE CLAIMED ELEMENTS OF THE '667 PATENT OBVIOUS	28

A.	Claims 1-3, 5-8, 13-16, 18-20, 22, 26, 28, and 29 Are Rendered Obvious by Orametrix In View of Faul, Further In View of Breton Further in View of Knighton.....	28
1.	Claim 1 Is Rendered Obvious by Orametrix In View of Faul, Breton, and Knighton.....	31
2.	Claim 2 Is Rendered Obvious by Orametrix In View of Faul, Breton, and Knighton.....	45
3.	Claim 3 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton.....	46
4.	Claim 5 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton.....	47
5.	Claim 6 Is Rendered Obvious by Orametrix in View of Faul.....	49
6.	Claim 7 Is Rendered Obvious by Orametrix in View of Faul.....	50
7.	Claim 8 Is Rendered Obvious by Orametrix and Faul	52
8.	Claim 13 Is Rendered Obvious by Orametrix in View of Faul and Knighton.....	53
9.	Claim 14 Is Rendered Obvious by Orametrix in View of Faul, Breton, and Knighton.....	54
10.	Claim 15 Is Rendered Obvious by Orametrix and Faul	68
11.	Claim 16 Is Rendered Obvious by Orametrix in View of Faul and Knighton.....	69
12.	Claim 18 Is Rendered Obvious by Orametrix in View of Faul, Further in View of Knighton	71
13.	Claim 19 Is Rendered Obvious by Orametrix in View of Faul and Breton.....	72
14.	Claim 20 Is Rendered Obvious by Orametrix in View of Faul and Breton.....	73
15.	Claim 22 Is Rendered Obvious by Orametrix in View of Faul and Breton.....	74
16.	Claim 26 Is Rendered Obvious by Orametrix In View of Faul, Breton, and Knighton.....	76
17.	Claim 28 Is Rendered Obvious by Orametrix in View of Faul and Knighton.....	91
18.	Claim 29 Is Rendered Obvious by Orametrix in View of Faul.....	92
XI.	CONCLUSION.....	94

I, Dr. Rongguang Liang, declare as follows:

I. INTRODUCTION

1. I have been retained by Medit Corporation (“Petitioner”) as an independent expert in this *inter partes* review before the United States Patent and Trademark Office (“PTO”) regarding U.S. Patent No. 11,368,667 (“the ’667 patent”), Ex-1001. Specifically, I have been asked to consider whether certain references disclose or suggest the features recited in claims 1-3, 5-8, 13-16, 18-20, 22, 26, 28, and 29 of the ’667 patent (“challenged claims”). As explained below, it is my opinion that the challenged claims are invalid as anticipated and/or obvious in view of the prior art references discussed in this Declaration and the accompanying Petition.

2. I am being compensated at my ordinary consulting rate of \$ 350.00 per hour. No part of my compensation is dependent on the outcome of this proceeding or any other proceeding involving the ’667 patent or any of its related patents. I have no other interests in this proceeding.

II. QUALIFICATIONS

3. My qualifications are generally set forth in my Curriculum Vitae, which is attached as Ex-1009. My Curriculum Vitae also includes a list of the publications I have authored and a list of the other cases in which I have testified during the last

four years.

4. I possess a comprehensive background in 3D imaging technologies, encompassing techniques such as triangular technology, fringe projection, confocal technology, depth from defocus, and optical coherence tomography. Leveraging this expertise, I have developed commercial 3D imaging devices tailored for dental and other medical applications, along with various general industrial applications.

5. I have engaged in research related to dentistry and optics since 2006. Several of my current and past research projects have also been related to or had particular applications in dentistry. Examples of such projects include: *Bimodal Intraoral Imaging Device for Detection of Oral Epithelial Neoplasia*; *Low-Cost and Compact Multimodal Intraoral Confocal Probe for Oral Cancer Detection and Diagnosis*; and *Low Cost Tri-modal Intra-oral camera for Early Detection of Caries and Cracks*.

6. I am a named inventor on over 50 patents or patent applications, including 7 patents in 3D imaging and shade measurement of teeth:

- U.S. Patent No. 11,605,172 Digital fringe projection and multi-spectral polarization imaging for rapid 3D reconstruction
- U.S. Patent No. 9,314,150 System and method for detecting tooth cracks via surface contour imaging

- U.S. Patent No. 8,570,530 B2: Apparatus for dental surface shape and shade imaging
- U.S. Patent No. 8,134,719 B2: 3-D imaging using telecentric defocus
- U.S. Patent No. 7,929,151 B2: Intra-oral camera for diagnostic and cosmetic imaging
- U.S. Patent No. 8,075,308 B2: Intra-oral camera for diagnostic and cosmetic imaging
- U.S. Patent No. 8,416,984 B2: Automatic tooth charting using digital images

A. Industry Experience

7. From 1989 to 1996, I worked at Micro-Optic Industrial Group Co. in Xiamen, P. R. China as an Optical Engineer in the Research & Development Department. From 2001 to 2007, I worked at Eastman Kodak Co. in Rochester, NY in various roles, including as a Principal Research Scientist in the Medical Science and Technology Center, Research & Development Lab. From 2007 to 2011, I worked at Carestream Health, Inc. as a Senior Principal Research Scientist.

B. Academic Experience

8. Since 2011, I have served as an Associate Professor and Professor in the College of Optical Sciences at The University of Arizona.

C. Other Relevant Experience

9. I have authored or contributed to over 150 publications in the field of optics. I was the editor of *Biomedical Optical Imaging Technologies: Design and Applications*, SPRINGER PRESS (2012), the author of *Optical Design for Biomedical Imaging*, SPIE PRESS (2011), and a co-author in the book chapter Shaun Pacheco, Zhenyue Chen, and Rongguang Liang, *Optics of Biomedical Instrumentation in Handbook of Optical Engineering* (2nd ed), MARCEL DEKKER (2016).

10. I have also served on the editorial boards of several publications. For example, I have served as an Associate Editor for *Optica* from 2015 to 2021. I served on the Editorial Board of *Scientific Reports* from 2018 to 2019. I served as a Topical Editor for *Applied Optics* from 2008 to 2014.

11. I have also chaired numerous conferences, including: Design and Quality Biomedical Technologies (SPIE) (2008-2019); Frontier in Optics, FiO.1 (OSA) (2014-2015); Bio-Optics: Design and Application (OSA) (2011, 2013); The Nature of Light: Light in Nature (SPIE) (2012, 2014, 2016).

III. MATERIALS CONSIDERED

12. My opinions, as set forth in this Declaration, are based on the documents I have reviewed, my experience and background, and my knowledge and professional judgment. In forming these opinions, I have reviewed the '667 patent

(Ex-1001), the prosecution history for the '667 patent (Ex-1002), the prior art discussed below, and any other material and information identified in this Declaration. I have also relied on my experience and knowledge in the field of optical measuring and testing and three-dimensional imaging.

13. In particular, my opinions regarding the invalidity of the challenged claims are based on the following prior art references, as informed by my knowledge in the field of optical measuring and testing and three-dimensional imaging.

Exhibit	Description
1001	U.S. Patent No. 11,368,667 (“the ’667 patent”)
1002	Excerpts from the File History of 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. Application Publication No. 2005/0237581 (“Knighton”)
1009	Curriculum Vitae of Rongguang Liang, PhD
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”, Inside Dentistry (April 2009) (“Birnbaum”)
1012	U.S. Patent No. 11,076,146 (“the ’146 patent”)

IV. TECHNOLOGY BACKGROUND

14. I understand that the ’667 patent issued on June 21, 2022, and claims priority to a provisional application that was filed on June 17, 2009. The ’667 patent purportedly relates to optical scanning for three-dimensional modeling of surfaces, such as teeth and soft tissue. *See, e.g.,* Ex-1001 at 1:26-43. In particular, the ’667 patent discusses using a projected pattern, which is either static or time-varying, to scan a surface and thereby measure the three-dimensional shape of the surface. *See, e.g., id.* at 3:10-25.

15. Projecting time-varying structured light patterns to optically scan and model three-dimensional surfaces is well known and predates the June 2009 priority date of the ’667 patent by many years. For example, Valkenburg, which was

published in 1998, describes a 3D measurement system using structured light. *See, e.g.,* Ex-1007 at Abstract; Fig. 1. Structured light is generated by directing a light source at a pattern, such as a grid or grating, thereby projecting a pattern of light that is composed of brighter and darker features, which can be coded. In Valkenburg, the structured light is referred to as coded strip patterns, and the pattern can be as simple as a single stripe. *See, e.g., id.* at 99; Figs. 1, 2. As illustrated in Figure 1, Valkenburg describes projecting a sequence of coded stripe patterns onto a scene and capturing a reflected image with a camera:

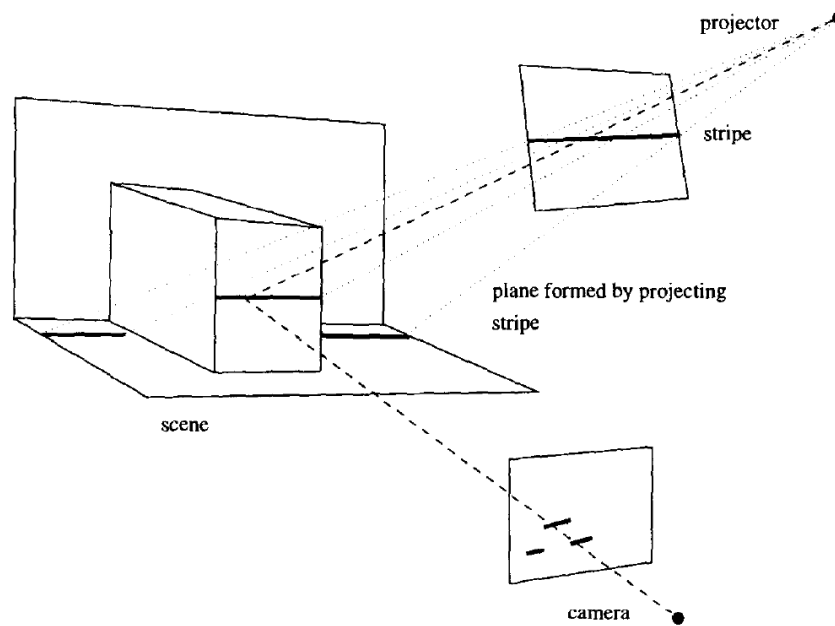


Fig. 1. Idealised structured light system.

16. As Valkenburg explains, the coded stripe patterns provide stripe value and image locations with pixel coordinates. *Id.* at 99. From the stripe values and the pixel coordinates, rays and planes can be used to define unique three-dimensional

data. *Id.* The projected stripe patterns are temporally encoded, so that the stripe pattern projected on the measured surface changes over time. *See id.*; Fig. 2:

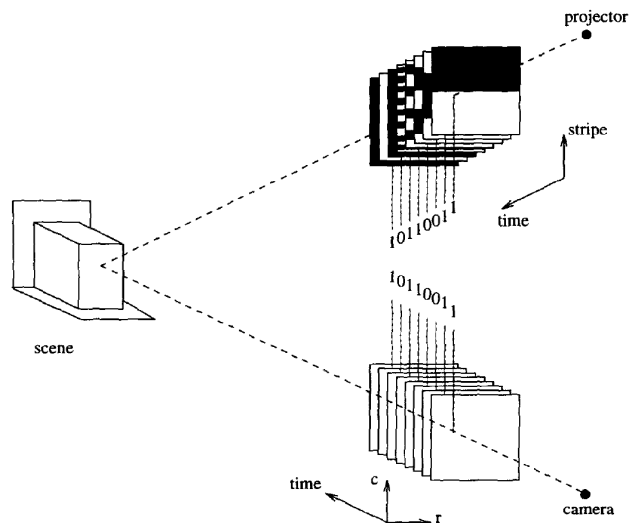


Fig. 2. Temporal encoding scheme.

17. As illustrated by Valkenburg above, only a single projector and camera are required to obtain measurements for three dimensional modeling. *Id.* at Figs. 1, 2. The light source used for projecting the structured pattern can be a laser or an LED light source. *See, e.g.*, Ex-1010 at [0337] (describing a LED source for pattern projection). *See also, e.g.*, Ex-1011 at 2 (describing the advantages of blue LEDs in pattern projection).

V. OVERVIEW OF THE '667 PATENT

A. Specification of the '667 Patent

18. 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 3D geometry and color of at least part of the surface of the scanned object. *Id.* at 2:46-48; 33:50-34:22. Figure 8 illustrates an example embodiment of a scanner configured for simultaneous measurement of color and shape:

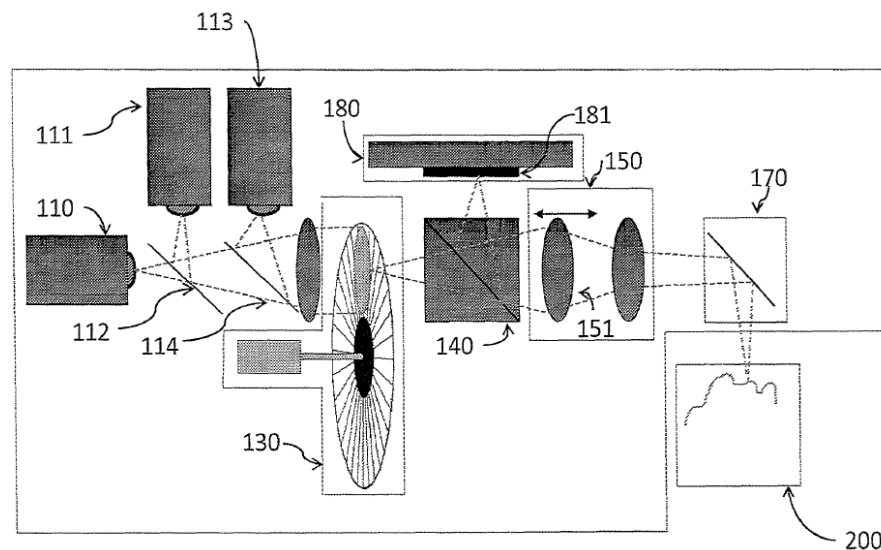


Fig. 8

19. The scanner includes pattern generation 130, which is used to generate a time-varying pattern that is projected onto the surface of scanned object 200. *Id.* at 28:3-13; 29:46-61. The pattern is changed over time by rotating the pattern generator, but may also be varied by translating the pattern over the object to be scanned. *See, e.g., id.* at 3:10-17; 8:38-59; 10:53-55; 28:4-13. The scanner also varies the position of the focal plane for the scanner via the focusing element 151 in optical system 150 and obtains images of the projected time varying pattern on the

scanned object at different 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 for each pixel. *See, e.g., id.* at 3:62-4:7.

20. In order to determine the color of the scanned object, the scanner describes using three lights sources (110, 111, 113) emitting red, blue, and green light. *See e.g., id.* at 33:49-34:4. In one example embodiment, the lights sources are activated sequentially, providing a single color image of the time-varying pattern on the object. *Id.* The color of the scanned object surface is determined by weighting the detected amplitude signals for each color. *Id.* at 34:1-4.

21. The '667 patent briefly discusses that the scanner may be wireless, but that wireless operation increases the need for local data processing because the 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 motion. *Id.* at 24:11-48.

22. The '667 patent also mentions that the camera (e.g., 180/181) may be a standard camera element or a high-speed camera that incorporates multiple A/D converters per line of pixels. *Id.* at 8:4-11.

B. Prosecution History

23. It is my understanding that the claims that issued for the '667 patent were added by preliminary amendment before examination, and that the issued

claims were allowed by the examiner on the first office action. Ex-1002. It is also my understanding that 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. I am told by counsel that terminal disclaimers are typically filed to overcome double patenting rejections, which means that the USPTO considers the claimed inventions of two patents to be obvious variants of each other, as discussed in more detail below with respect to obviousness.

VI. LEGAL PRINCIPLES USED IN ANALYSIS

24. I am not an attorney and I offer no opinions on the law. I have been advised by Petitioner's counsel of certain legal principles relevant to an invalidity analysis, as summarized below. I have conducted my analysis in accordance with these principles.

A. Prior Art

25. I understand that a patent or other publication must qualify as prior art before it can be used to invalidate a patent claim.

26. I understand that a U.S. or foreign patent qualifies as prior art to a challenged claim if the patent was issued prior to the invention date of the challenged claim. I also understand that a U.S. or foreign patent or published patent application qualifies as prior art to a challenged claim if it was published before the invention

date of the challenged claim.

B. Anticipation

27. I understand that a prior art reference “anticipates” an asserted claim, thereby rendering the claim invalid, if all elements of the claim are disclosed in the reference, either expressly or inherently. I understand that an element is disclosed inherently in a prior art reference if it is necessarily present in the prior art reference or is the natural result flowing from the disclosure of the prior art reference. I have been informed that a prior art reference does not need to use the same words as the challenged claim in order to anticipate the claim.

C. Obviousness

28. I also understand that a patent is invalid if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious to a person of ordinary skill in the pertinent art at the time the invention was made. I understand that a POSITA provides a reference point from which the prior art and claimed invention should be viewed. This reference point prevents one from using his or her own personal insight or hindsight in deciding whether a claim is obvious.

29. I understand that an obviousness determination includes the consideration of various factors, such as (1) the scope and content of the prior art,

(2) the differences between the prior art and the asserted claims, (3) the level of ordinary skill in the pertinent art, and (4) the existence of secondary considerations such as commercial success, long-felt but unresolved needs, failure of others, etc.

30. I understand that an obviousness evaluation can be based on a combination of multiple prior art references. I understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, which does not need to be explicit. I further understand that any need or problem known in the field and addressed by the patent can provide a reason for combining the elements in the manner claimed. To determine whether there was an apparent reason to combine the known elements in the way a patent claims, I have been informed that I may look to interrelated teachings of multiple patents, to the effects of demands known to the relevant community or present in the marketplace, and to the background knowledge possessed by a POSITA. I also understand that practical and common-sense considerations should guide a proper obviousness analysis because familiar items may have obvious uses beyond their primary purposes. I further understand that a POSITA looking to overcome a problem will often be able to fit together the teachings of multiple publications. I understand that an obviousness analysis therefore accounts for the inferences and creative steps that a POSITA would employ under the circumstances.

31. I understand that the nexus linking two or more prior art references can also be simple common sense. I further understand that the obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

32. I understand that if a technique has been used to improve one device, and a POSITA would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

33. I understand that a particular combination may be proven obvious merely by showing that it was obvious to try the combination. For example, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a POSITA has good reason to pursue the known options within his or her technical grasp because the result is likely not the product of innovation, but of ordinary skill and common sense.

34. I understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. When a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different

field. If a POSITA can implement a predictable variation, the patent claim is likely obvious.

35. As noted above, I understand that a proper obviousness analysis focuses on what was known or obvious to a POSITA, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

36. I understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense or knowledge of one of skill in the art.

37. I also understand that secondary indicia of non-obviousness may include: (1) a long-felt but unmet need in the prior art that was satisfied by the invention of the patent; (2) commercial success of processes covered by the patent; (3) unexpected results achieved by the invention; (4) praise of the invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the invention; (7) failure of others to find a solution to the long-felt need; and (8) skepticism by experts.

38. I also understand that there must be a relationship between any such

secondary considerations and the invention. I further understand that contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination.

39. I further understand that an obviousness determination does not require an actual, physical substitution of elements from multiple references. Instead, the criteria is whether the claimed inventions are rendered obvious by the teaching of the prior art of the whole, not whether the references could be physically combined.

40. In sum, it is my understanding that prior art teachings are properly combined where a POSITA—having the understanding and knowledge reflected in the prior art and being motivated by the general problem facing the inventor—would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

D. Claim Construction

41. I understand that, before an invalidity analysis can be performed, the scope and meaning of the challenged claims must be determined. It is my understanding that this is accomplished through the process of claim construction.

42. I have been informed and understand that claims are generally

construed from the perspective of a POSITA at the time of the invention, which I have been asked to assume is the '667 patent's priority date of June 17, 2009. More specifically, I understand that the claims should be afforded a meaning in accordance with the ordinary and customary meaning of the claim, as understood by a POSITA at the time of the invention.

43. I have been advised that, in construing a claim term, one must first look to the "intrinsic" patent evidence, which includes the claims themselves, the patent specification, and the prosecution history of the patent. I have also been informed that "extrinsic" evidence, which is outside the patent and prosecution history, may be useful in construing patent claims. It is my understanding that such extrinsic evidence may include dictionaries, textbooks, treatises, and similar sources of information.

44. I have been advised that a claim may recite a function to be performed rather than a structure for performing the function. I have been informed that such claim terms are known as "means-plus-function" claim terms. I understand that a term introduced by the phrase "means for" is presumed to be a means-plus-function claim term. I have also been informed that a claim term may be construed as a means-plus-function term where it fails to recite sufficiently definite structure, or else recites function without reciting sufficient structure for performing that function.

45. I have been advised that the construction of a means-plus-function claim term is a two-step process. I understand that the first step requires an identification of the function recited in the claim. I understand that the second step requires determining what structure is disclosed in the specification for performing the recited function. I have been advised that a structure disclosed in the patent specification qualifies as corresponding structure if the intrinsic evidence clearly links or associates that structure to the function recited in the claim. I have been advised that the proper construction for a means-plus-function term is restricted to the corresponding structure identified in the specification and equivalents thereof.

46. I understand that claims must be construed in an *inter partes* review using the same claim construction standard that would be used to construe the claim in a civil action before a District Court.

VII. LEVEL OF ORDINARY SKILL IN THE ART

47. My opinions have been guided by my appreciation of how a POSITA (described below) would have understood the claims of the '667 patent as of the invention date, which I have been asked to assume is the patent's priority date, June 17, 2009.

48. It is my understanding that a POSITA is one who is presumed to be aware of all pertinent art and is a person of ordinary creativity. I further understand

that the following factors may be considered in establishing the level of ordinary skill in the art in the relevant field: the type of problems encountered in the art; the prior art solutions to those problems; the rapidity with which innovations are made; sophistication of the technology; and the educational level of active workers in the field.

49. In June of 2009, it is my opinion that 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. Furthermore it is my opinion that a POSITA would have had experience with, and knowledge of, 3D imaging systems and 3D modeling techniques.

VIII. CLAIM CONSTRUCTION

50. I have set forth my understanding of relevant claim construction principles above, which I have followed in my analysis. Below I discuss two claim terms that were construed by the District Court in the related litigation. In my view, the remaining claim terms should be given their plain and ordinary meaning.

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

51. Counsel has informed me that the District Court has determined that the preambles of independent claims 1, 14, and 26 are not limiting and should be

afforded its plain and ordinary meaning. Ex-1006 at 4. For the purposes of this declaration, I have adopted this construction in my analysis.

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

52. Claims 8 and 15 recite “data for the 3D geometry.” Counsel informs me that the District Court has construed “data for the 3D geometry” to mean “the data for the 3D geometry.” Ex-1006 at 4. For the purposes of this declaration, I have adopted the District Court’s construction of this term.

IX. OVERVIEW OF THE PRIOR ART

A. Orametrix

53. 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 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

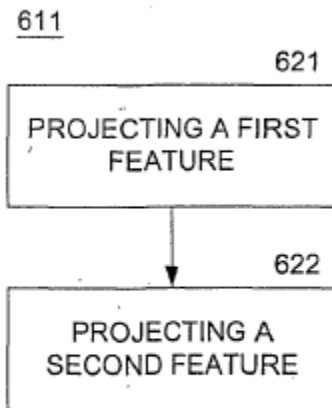


FIGURE 19

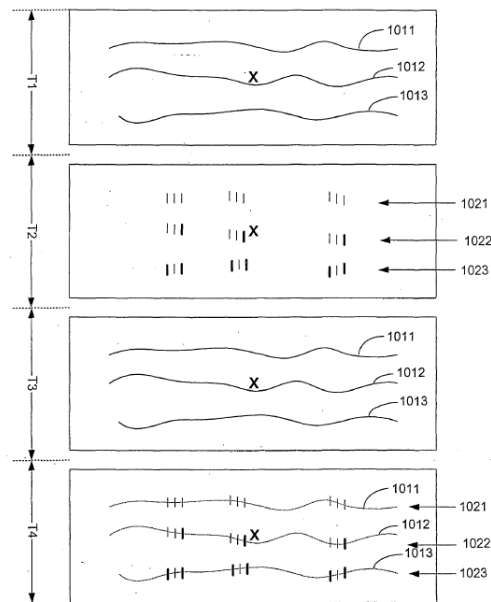
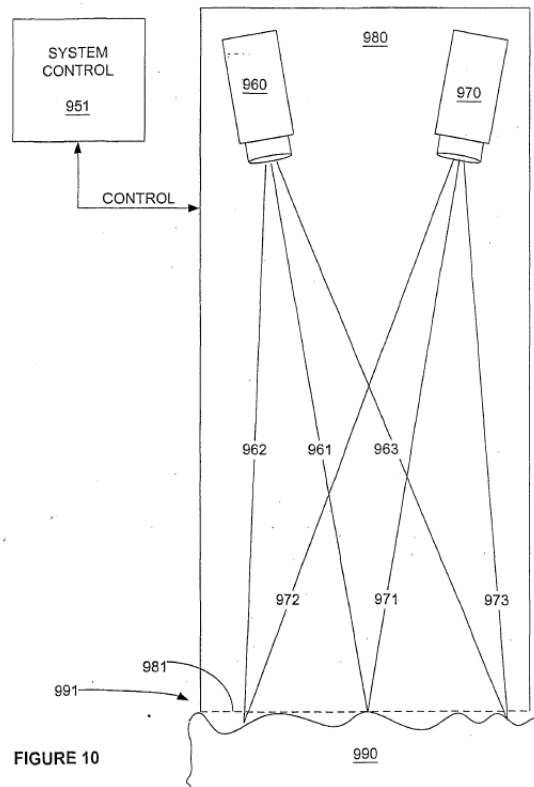


Figure 23

54. 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.



55. 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.

56. Orametrix also describes a registration process by which adjacent image frames are stitched together to form an integrated map of the surface of the scanned object. *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 three dimensional models from a plurality of scans. *See, e.g., id.* at 60:18-61:7.

57. Orametrix additionally discloses that in the scanning process, different patterns are projected over different periods of time. *Id.* at 29:8-19; Figs. 16, 19, 23. 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:

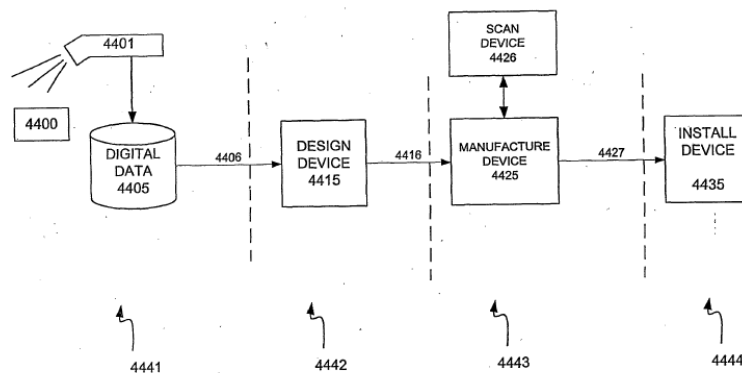
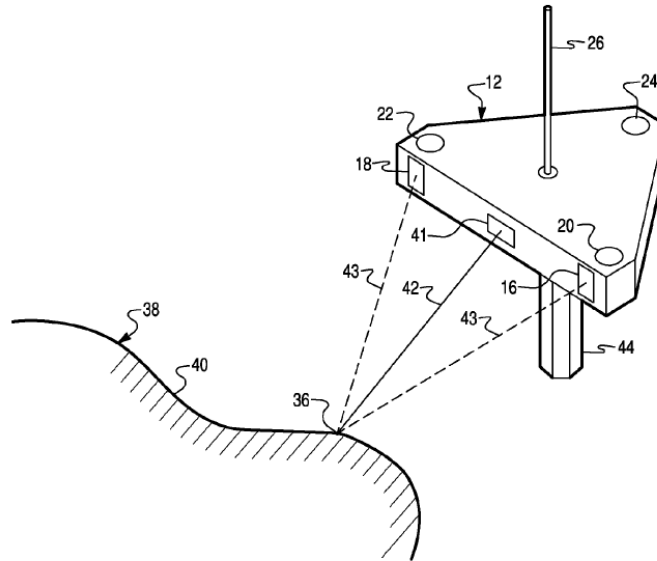


FIGURE 44

B. Faul

58. Faul describes 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



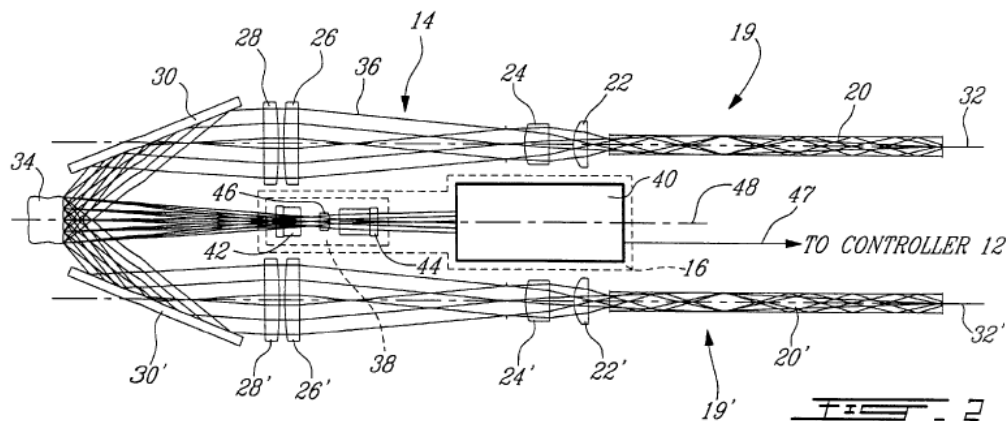
59. This shape determination is made by projecting dynamically-varied, structured light on a surface to be measured by means of a digital video projector. *See id.* at 4:36-53. The structured light is varied over time so that varying patterns are projected on the scanned surface. *Id.* Faul also describes measuring the color of the scanned surface by 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 optical imaging sensors to determine the color and shape of the surface. *Id.* at 4:59-5:9; 5:38-51 (describing the process for transforming 2D data to 3D data); 6:60-67 (describing that surface model 80 includes color or texture data in addition to geometrical shape data); Fig. 2. Faul also describes performing processing within the wireless scanner to reduce

the amount of transmitted data to a workstation. *See, e.g., id.* at 12:43-63.

C. Breton

60. 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.



61. 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 acquiring spatial resolution data that is used to build a position registry. *Id.* at 7:39-52. This position registry corresponds to a spectral map that is built from a complete spectral decomposition of every scanned point. *Id.* From the position registry and spectral map, the shape and color of the scanned surface is

determined. *Id.* Breton also discloses that the color of the teeth can be accurately measured only using 3 sampling bands in the red, blue, and green portions of the wavelength spectrum, and that limiting the spectral band samples can reduce computation time. *Id.* at 8:24-36.

D. Knighton

62. Knighton describes a wireless, hand-held portable three-dimensional scanner. *See, e.g.*, Ex-1008 at Abstract; [0033]; Fig. 1.

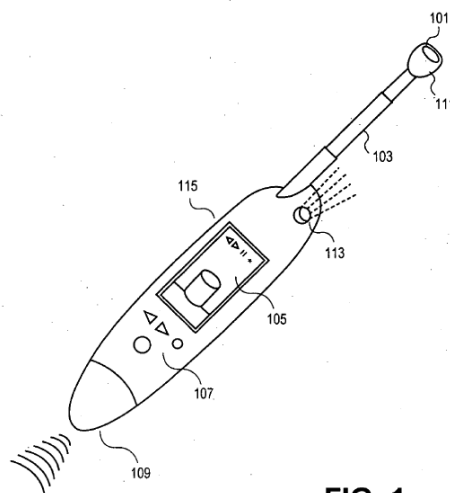


FIG. 1

63. 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 three-dimensional 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 three-dimensional 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].

X. THE PRIOR ART RENDERS ALL OF THE CLAIMED ELEMENTS OF THE '667 PATENT OBVIOUS

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

64. As discussed above in Section IX, Orametrix, Faul, Breton, and Knighton all describe measuring systems for acquiring the color and shape of scanned objects. As such, it is my opinion that these four references belong to the same technical field, provide similar scanning systems, and thus provide elements and features that a POSITA would have looked to in order to arrive at the combination of elements comprising the invention described by the claims.

Furthermore, because they each describe similar scanning systems with similar objectives, it is my opinion that a POSITA would have had a reasonable expectation of success in combining Orametrix, Faul, and Breton in order to achieve accurate color and shape measurements in three-dimensional models of scanned objects. It is my opinion that 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.

65. 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].

66. 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. Thus, because Orametrix, Faul, Breton, and Knighton are in the same field, and have the same purpose to increase objectivity and accuracy in three-dimensional modeling of real world objects, it is my opinion that a POSITA would have been motivated to combine the various elements of these four references to increase the accuracy of the color and shape measurements underlying the subsequent three dimensional modeling of the real world objects.

67. A POSITA also would have had an 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.

68. As a result, it is my opinion that the combined teachings of these references, the knowledge, creativity, and common sense of a POSITA and the

nature of the problem to be solved would have led a POSITA to the claimed combination and would have indicated a reasonable likelihood of success in making the above referenced combination.

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

69. As explained below, it is my opinion that Orametrix in view of Faul Breton, and Knighton teaches, and therefore renders obvious every element of claim 1.

a. [Claim 1pre]: “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:”

70. As discussed above in Section VIII.A, I have been informed that the District Court determined that the preamble of claim 1 is not limiting. Nevertheless, it is my opinion that 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. Orametrix further teaches that the scanner would be held by a user, for example, a user in a home setting. *See, e.g., id.* at 58:1-14.

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

71. It is my opinion that Orametrix teaches this claim element. Orametrix

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

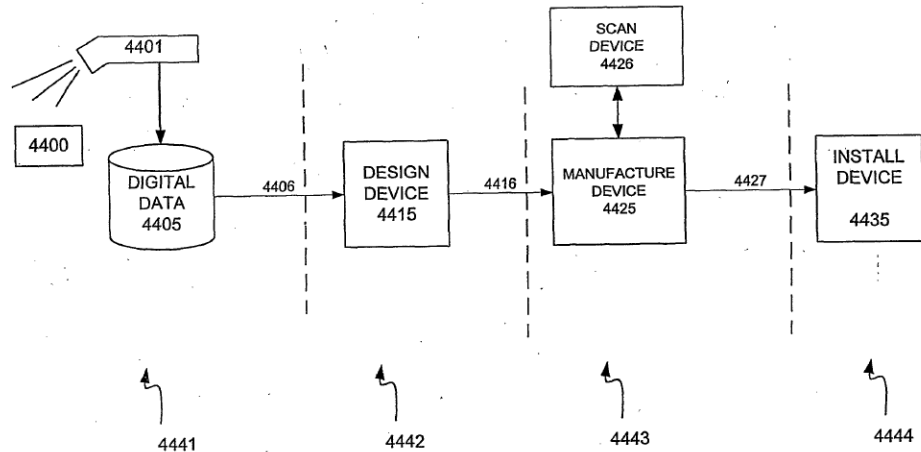


FIGURE 44

72. 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). It is my opinion that the scanner illustrated in Figure 44, in combination with the description of direct scanning of anatomical structures teaches the claimed “tip” limitation. Furthermore, it is my opinion that 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.

73. Therefore, it is my opinion that Orametrix renders obvious “a tip configured to be inserted into the oral cavity,” as recited by this element of claim 1.

c. [Claim 1b]: “at least one camera accommodating an

array of sensor elements;”

74. It is my opinion that Orametrix teaches this limitation and therefore renders it obvious. 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. It is my opinion that a POSITA would understand the camera/viewer of Orametrix would necessarily include an array of sensor elements.

75. Therefore, it is my opinion that Orametrix renders obvious “at least one camera accommodating an array of sensor elements,” as recited by this claim element.

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;”

76. It is my opinion that both Orametrix and Faul each teaches this claim limitation and therefore renders it obvious. 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. System controller 951 provides specific information to scanner 980 specifying a specific image to be projected onto surface 991 of object 990. *Id.* at 15:19-21. Orametrix describes that the image to be projected can be a digital image that is

stored in memory by data processor 952. *Id.* at 17:11-19. Orametrix further describes that in the scanning process, different patterns can be projected over different periods of time. *Id.* at 29:8-19; Figs. 16, 19, 23. 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.*

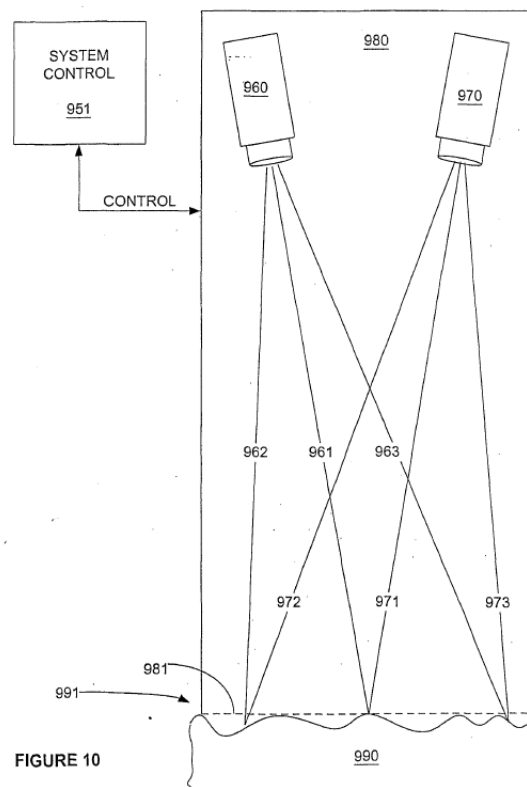
77. Faul also describes projecting a time-varying pattern of structured light to determine the shape of an object. *See* Ex-1004 at 4:36-53. Faul describes that the time-varying pattern can be generated by a digital video projector. *Id.* at 4:25-53; 5:53-54. Faul discloses that the scanner includes a microprocessor and memory, *id.* at 7:64-8:8, and it is my opinion that 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.

78. It is my opinion that 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. Thus, it is my opinion that Orametrix and Faul each teaches, and therefore renders obvious "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," as recited in claim 1.

- 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 . . .”

79. It is my opinion that Orametrix and Faul each teaches this limitation.

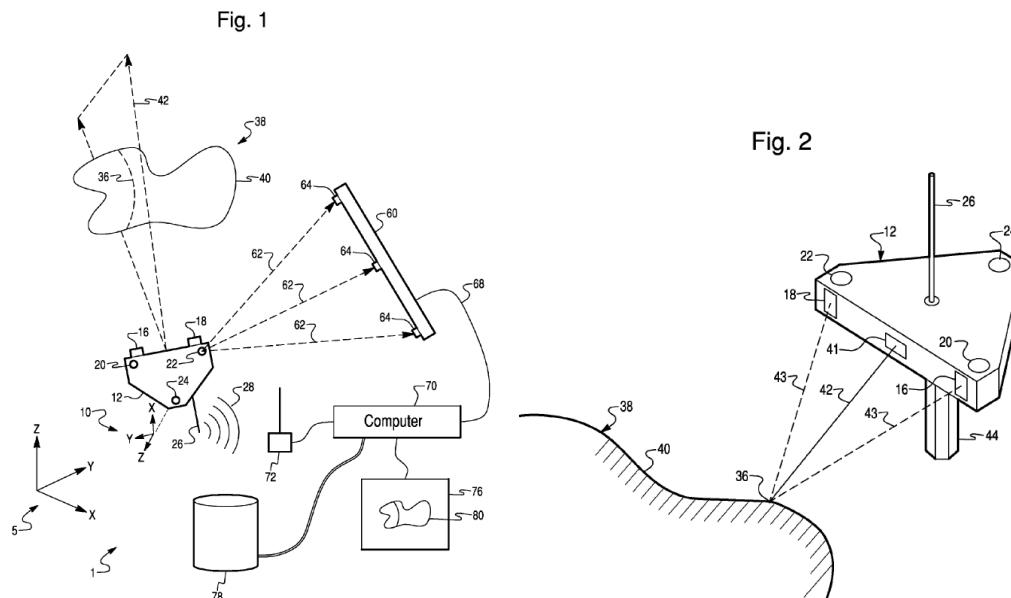
Figure 10 of Orametrix illustrates an optical system according to this claim element:



80. 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. The reflected light from the object is detected by viewing

device 970. *Id.* Orametrix further describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. *Id.* at 30:7-8. The 2D image frames are then converted into three dimensions using conventional 3D imaging techniques. *Id.* at 30:8-12. *See also id.* at 75 (claim 4). Also, as discussed above in Section X.A.1.b, it is my opinion that a POSITA would understand that the scanner of Orametrix would have a tip for directing the scanning illumination towards a tooth in a mouth.

81. It is my opinion that Faul also describes the elements of this claim limitation. Figures 1 and 2 of Faul illustrate the claimed optical system:



82. 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. 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. *Id.* at 4:59-9:25; 7:11-29. It is my opinion that 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. Therefore, it is my opinion that Orametrix and Faul each renders this claim element obvious.

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"

83. It is my opinion that Orametrix and Faul each renders this claim limitation obvious.

84. As discussed above in Section X.A.1.e, Orametrix describes that light projected by projector 960 reflected from the surface of object 990 is detected by viewing device 970. Ex-1005 at 16:6-13; Fig. 10.

85. 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.

86. It is my opinion that 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. Therefore, it is my opinion that Faul and Orametrix each renders this claim element obvious.

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

87. It is my opinion that Orametrix and Faul each renders this claim limitation obvious.

88. As discussed above in Section X.A.1.e, Orametrix describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. Ex-1005 at 30:7-8. The 2D image frames are then converted into three dimensions using conventional 3D imaging techniques. *Id.* at 30:8-12. *See also id.* at 75 (claim 4).

89. 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.

90. It is my opinion that 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. Therefore, it is my opinion that Orametrix and Faul each renders this claim element obvious.

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"

91. It is my opinion that Orametrix in view of Faul and Knighton teaches this claim element. Orametrix describes the direct measurement of anatomical structures, including teeth. Ex-1005 at 31:11-19; 56:11-20. Orametrix describes wirelessly communicating scanning data from the system to a client. *Id.* at 58:21-59:13; Fig. 44. This client may be, for example, design device 4415 at facility 4442, which is a workstation located remotely from scanner 4401. *Id.* See also *id.* at 62:19-21; 63:11-18 (describing facility 4442). 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. *Id.* at 58:1-14. Orametrix also describes an embodiment where probable movement of the scanner in the X, Y, and Z directions is determined. See, e.g., *id.* at 37:11-38:13. This movement data is used in the modeling process to perform registration between

image frames. *Id.* at 38:18-41:9. Given this disclosure, and in light of the descriptions of the scanner in Faul and Knighton, it is my opinion that a POSITA would understand that Orametrix's scanner would be wireless and communicating data wirelessly for remote processing.

92. Faul explicitly teaches the advantages of a wireless handheld scanner for obtaining scanning data of three dimensional 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. 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., id.* at 8:45-60. This position data is used to generate a set of 3D surface point coordinates that are used to model the scanned objects surface in three dimensions. *See, e.g., id.* at 3:11-24; 9:27-60.

93. As described above in Section IX.D, 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, e.g.*, Ex-1008 at [0044]. *See also id.* at [0033], [0045] (describing wireless configurations). Knighton further discloses that position and movement data may be generated by these sensors. *Id.* 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. *Id.* at [0080], [0082].

94. In my opinion 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.

95. Furthermore, it is my opinion that 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.

96. Therefore, it is my opinion that Orametrix in view of Faul and Knighton teaches “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,” as recited by this claim element.

- 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”**

97. It is my opinion that Orametrix or Faul further in view of Breton teaches this claim element. As described above in Section X.A.1.d, Orametrix describes scanning the object surface with a time-varying pattern to determine shape information. 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. 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. *Id.* at 64:6-15. 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.

98. Faul also describes projecting a time-varying pattern to determine the shape of an object. *See* Ex-1004 at 4:36-53. Faul describes a digital video projector for generating a time-varying pattern. *Id.* at 4:25-53; 4:36-52. Faul also describes measuring the color of the scanned surface. *See, e.g., id.* at 6:60-67. Faul also describes dynamically altering the color of the projected structured light. *See id.* 10:64-11:4. Faul discloses that the scanner includes a microprocessor, *id.* at 7:49-

8:8, and it is my opinion that 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.

99. 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. 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.* 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. *Id.* at 8:24-36.

100. In my opinion, 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. As discussed above 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. And as discussed above, Faul itself teaches color measurement and suggests dynamically changing the color of the projected time-varying structured light. It is my opinion that 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. Thus, it is my opinion that Orametrix or Faul, further in view of Breton, teaches “a hardware processor located within the wireless intraoral scanner, configured to: selectively switch a color of the probe light, thereby illuminating the object with different colors at different times,” as recited by 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.**

101. It is my opinion that Orametrix or Faul further in view of Breton teaches this claim element. As discussed above in Section X.A.1.c, both Orametrix and Faul teach recording images of the scanned surface at different times with different projected patterns. For example, Orametrix describes that the data may be a

composite of scans taken at different times. Ex-1005 at 57:7-16. Likewise, Faul describes assigning timestamps to each scanned image. Ex-1004 at 14:7-39. Faul also describes recording images of the object with different colors. *Id.* at 12:20-30; Fig. 4 (describing data format 403 that includes RGB color intensities for each point in the image). As discussed above in Section X.A.1.i, it is my opinion that 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. 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.

102. Thus, it is my opinion that the combination of Orametrix or Faul in view of Breton teaches "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 on camera at the different times," as recited by this claim element.

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

103. It is my opinion that Orametrix in view of Faul, Breton, and Knighton renders claim 2 obvious.

- 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.”**

104. As discussed above in Section X.A.1.i, Orametrix in view of Faul and Breton teaches changing colors of the projected structured light pattern. 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. Breton also teaches the advantages of limiting the color band analysis to the red, blue, and green color bands to conserve processing resources. *Id.* at 11:21-27. It is my opinion that 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.

105. Thus, it is my opinion that Orametrix in view of Faul, Breton, and Knighton renders obvious “wherein the light source further comprises at least three monochromatic light sources of the light source configured to provide the different colors,” as recited by claim 2.

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

106. It is my opinion that Orametrix in view of Faul, Breton, and Knighton renders claim 3 obvious.

- 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.”**

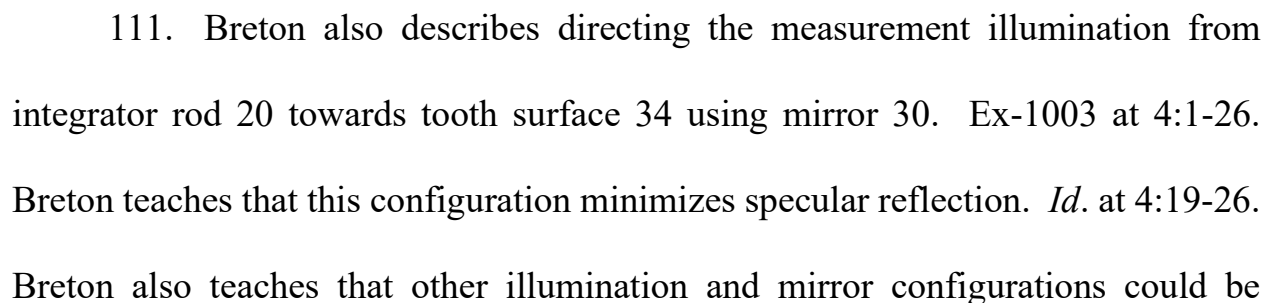
107. As discussed above in Sections IX.C, X.A.1.i, and X.A.2.a, Breton describes an illuminator assembly comprised of multiple light sources. Breton also teaches changing the wavelength of the light used to scan the tooth surface. Ex-1003 at 6:62-11. It is my opinion that a POSITA would selectively switch 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.

108. Thus, it is my opinion that Orametrix in view of Faul, Breton, and Knighton renders obvious “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,” as recited by claim 3.

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

109. It is my opinion that Orametrix in view of Faul, Breton, and Knighton

110. 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:



utilized. *Id.* It is my opinion that 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.

112. Therefore, it is my opinion that Orametrix in view of Faul, Breton, and Knighton renders obvious, “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 recited by claim 5.

5. Claim 6 Is Rendered Obvious by Orametrix in View of Faul

113. It is my opinion that Orametrix in view of Faul renders this claim obvious.

- 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.”**

114. As discussed above in Section X.A.1.f, Orametrix and Faul describe determining the 3D geometry based on the plurality of 2D images.

115. 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. Faul describes that subpixel coordinates of given points on the scanned 2D image are transformed into three-dimensional coordinates that are then transmitted. *Id.* at 12:27-32. Furthermore, as discussed in Section X.A.1.h, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. It is my opinion that 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.

116. Therefore, it is my opinion that Orametrix in view of Faul renders obvious “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,” as recited claim 6.

6. Claim 7 Is Rendered Obvious by Orametrix in View of Faul

117. It is my opinion that Orametrix in view of Faul renders this claim obvious.

- 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.”**

118. As discussed above in Section X.A.1.g, Orametrix and Faul describe determining the 3D geometry based on the plurality of 2D images.

119. 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. Faul describes that subpixel coordinates of given points on the scanned 2D image are transformed into three-dimensional coordinates that are then transmitted. *Id.* at 12:27-32. Faul specifically describes this local processing as significantly reducing the amount of transmitted geometric and color data as compared to conventional transmission. *Id.* at 12:43-50. It is my opinion that 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, as discussed in Section X.A.1.h, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. It is my opinion that 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.

120. Therefore it is my opinion that Orametrix in view of Faul renders obvious ” 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,” as recited in claim 7.

7. Claim 8 Is Rendered Obvious by Orametrix and Faul

121. It is my opinion that Orametrix and Faul each renders this claim obvious.

- 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.”**

122. Orametrix describes allowing for real-time viewing of a three-dimensional image of the scanned object. Ex-1005 at 34:12-15. Faul also describes rendering the geometry of a three-dimensional object in real-time. Ex-1004 at 8:56-60.

123. Therefore, it is my opinion that Orametrix and Faul each renders

obvious, “wherein the hardware processor is further configured to process the raw 3D data into data for the 3D geometry in real time,” as recited by claim 8.

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

124. It is my opinion that Orametrix in view of Faul and Knighton renders this claim obvious.

- 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.”**

125. As discussed in Sections IX.A and X.A.1.h, Orametrix describes using probable scanner position for registering and stitching partial scans of the object to create an integrated surface map of the object. Furthermore, as discussed in Section X.A.1.h, 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.

126. Therefore, it is my opinion that Orametrix in view of Faul and Knighton renders obvious “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,” as recited by claim 13.

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

127. As explained below, it is my opinion that Orametrix in view of Faul, Breton, and Knighton renders every element of claim 14 obvious.

a. [Claim 14pre]: “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:”

128. As discussed above in Section VIII.A, I have been informed that the District Court determined that the preamble of claim 14 is not limiting. Nevertheless, it is my opinion that 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. Orametrix further teaches that the scanner would be held by a user, for example, a user in a home setting. *See, e.g., id.* at 58:1-14.

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

129. It is my opinion that Orametrix teaches this claim element. Orametrix describes a scanning device 4401 that shows a tip, as illustrated in Figure 44:

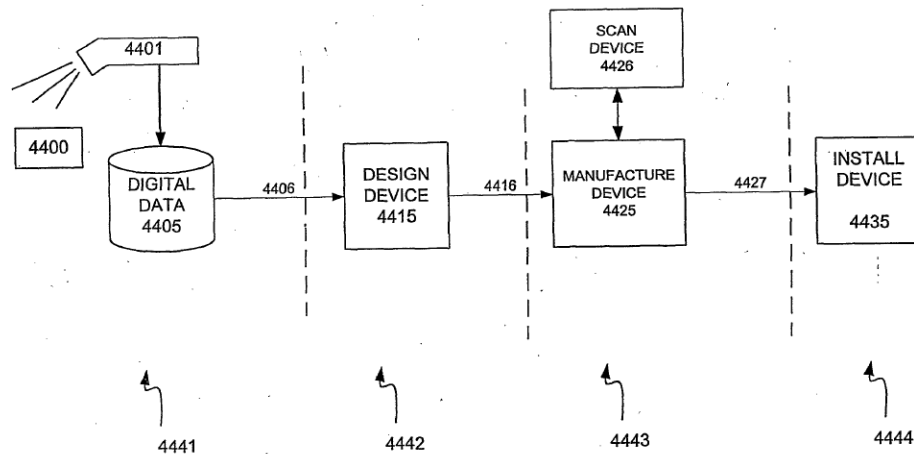


FIGURE 44

130. 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). It is my opinion that the scanner illustrated in Figure 44, in combination with the description of direct scanning of anatomical structures teaches the claimed “tip” limitation. Furthermore, it is my opinion that 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.

131. Therefore, it is my opinion that Orametrix renders obvious “a tip configured to be inserted into the oral cavity,” as recited by this element of claim 14.

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

132. It is my opinion that Orametrix teaches this limitation and therefore renders it obvious. 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 id.* at 4:3-10; 16:6-13; 34:4-6. It is my opinion that a POSITA would understand the camera/viewer of Orametrix would necessarily include an array of sensor elements.

133. Therefore, it is my opinion that Orametrix renders obvious “at least one camera accommodating an array of sensor elements,” as recited by this claim element.

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;”

134. It is my opinion that Orametrix and Faul each teaches this claim limitation and therefore render it obvious. 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. System controller 951 provides specific information to scanner 980 specifying a specific image to be projected onto surface 991 of object 990. *Id.* at 15:19-21.

Orametrix describes that the image to be projected can be a digital image that is stored in memory by data processor 952. *Id.* at 17:11-19. Orametrix further describes that in the scanning process, different patterns can be projected over different periods of time. *Id.* at 29:8-19; Figs. 16, 19, 23. 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.*

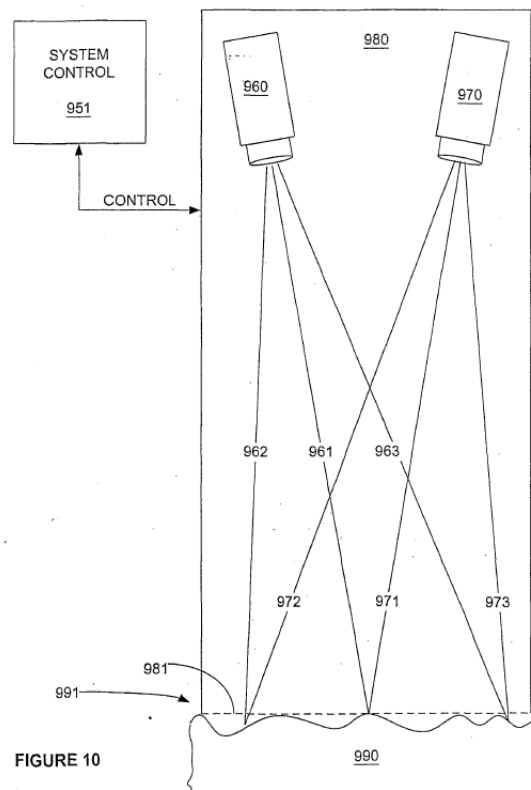
135. Faul also describes projecting a time-varying pattern of structured light to determine the shape of an object. *See* Ex-1004 at 4:36-53. Faul describes generating a time-varying pattern with a digital video projector. *Id.* at 4:25-53; 5:53-54. Faul discloses that the scanner includes a microprocessor and memory, *id.* at 7:64-8:8, and it is my opinion that 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.

136. It is my opinion that 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. Thus, it is my opinion that Orametrix and Faul each teaches, and therefore renders obvious "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,” as recited in claim 14.

- 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 . . .”**

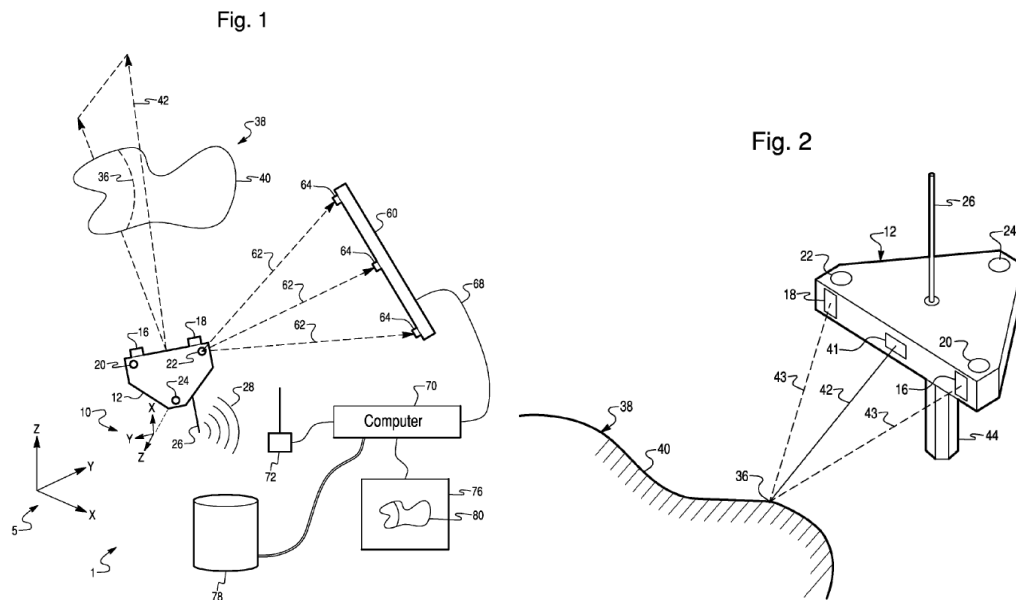
137. It is my opinion that Orametrix and Faul teaches this limitation. Figure 10 of Orametrix illustrates an optical system according to this claim element:



138. 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. The reflected light from the object is detected by viewing device 970. *Id.* Orametrix further describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. *Id.* at 30:7-8. The 2D image frames are then converted into three dimensions using conventional 3D imaging techniques. *Id.* at 30:8-12. *See also id.* at 75 (claim 4). Also, as discussed above in Sections X.A.1.b and X.A.9.b, it is my opinion that a POSITA would understand that the scanner of Orametrix would have a tip for directing the scanning illumination towards a tooth in a mouth.

139. It is my opinion that Faul also describes the elements of this claim limitation. Figures 1 and 2 of Faul illustrate the claimed optical system:



140. 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. 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. *Id.* at 4:59-9:25; 7:11-29.

141. It is my opinion that 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. Therefore, it is my opinion that both Orametrix and Faul render this claim element obvious.

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"

142. It is my opinion that both Orametrix and Faul each renders this claim limitation obvious.

143. As discussed above in Section X.A.1.e, Orametrix describes that light projected by projector 960 reflected from the surface of object 990 is detected by viewing device 970. Ex-1005 at 16:6-13; Fig. 10.

144. 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.

145. It is my opinion that 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. Therefore, it is my opinion that Faul and Orametrix each renders this claim element obvious.

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

146. It is my opinion that Orametrix and Faul each renders this claim limitation obvious.

147. As discussed above in Section X.A.1.g, Orametrix describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. Ex-1005 at 30:7-8. The 2D image frames are then converted into three dimensions using conventional 3D imaging techniques. *Id.* at 30:8-12. *See also id.* at 75 (claim 4).

148. 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.

149. It is my opinion that 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. Therefore, it is my opinion that Orametrix and Faul each renders this claim element obvious.

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;"

150. It is my opinion that Orametrix or Faul further in view of Breton teaches this claim element. As described above in Section X.A.1.c, Orametrix describes scanning the object surface with a time-varying pattern to determine shape information. 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. 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. *Id.* at 64:6-15. 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.

151. Faul also describes projecting a time-varying pattern to determine the shape of an object. *See* Ex-1004 at 4:36-53. Faul describes that the time-varying pattern is generated by a digital video projector. *Id.* at 4:25-53; 4:36-52; 5:53-54. Faul also describes measuring the color of the scanned surface. *See, e.g., id.* at 6:60-67. Faul also describes dynamically altering the color of the projected structured light. *See id.* 10:64-11:4. Faul discloses that the scanner includes a microprocessor, *id.* at 7:49-8:8, and it is my opinion that 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.

152. 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. 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.* 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. *Id.* at 8:24-36.

153. In my opinion, 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. As discussed above 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. And as discussed above, Faul itself teaches color measurement and suggests dynamically changing the color of the projected time-varying structured light. It is my opinion that 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. Thus, it is my opinion that Orametrix and Faul, further in view of Breton, teaches “a hardware processor located within the wireless intraoral scanner, configured to: selectively switch a color of the probe light, thereby illuminating the object with different colors at different times,” as recited by this claim element.

- 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;”**

154. It is my opinion that Orametrix or Faul further in view of Breton teaches this claim element. As discussed above in Section X.A.1.i, both Orametrix and Faul teach recording images of the scanned surface at different times with different projected patterns. For example Orametrix describes that the data may be a composite of scans taken at different times. Ex-1005 at 57:7-16. Likewise, Faul describes assigning timestamps to each scanned image. Ex-1004 at 14:7-39. Faul also describes recording images of the object with different colors. *Id.* at 12:20-30; Fig. 4 (describing data format 403 that includes RGB color intensities for each point in the image). As discussed above in Section X.A.1.h, it is my opinion that 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. 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.

155. Thus, it is my opinion that the combination of Orametrix or Faul in view

of Breton teaches “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,” as recited by this claim element.

- 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”**

156. As discussed above in Section X.1.A.g, Orametrix and Faul describe determining the 3D geometry based on the plurality of 2D images.

157. 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. Faul describes that the subpixel coordinates of given points within the scanned 2D images are transformed into three-dimensional coordinates that are then transmitted. *Id.* at 12:27-32. Furthermore, as discussed in Section X.A.1.h, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. It is my opinion that 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.

158. Therefore, it is my opinion that Orametrix in view of Faul renders obvious “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,” as recited by this claim element.

- 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.”**

159. As discussed above in Section X.1.A.g, Orametrix and Faul describe determining the 3D geometry based on the plurality of 2D images.

160. 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. Faul describes that the subpixel coordinates of given points within the scanned 2D images are transformed into three-dimensional coordinates that are then transmitted. *Id.* at 12:27-32. Faul specifically describes that this local processing significantly reduces the amount of transmitted geometric and color data, as compared to conventional transmission. *Id.* at 12:43-50. It is my opinion that 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, as discussed in Section X.A.1.h, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. It is my opinion that 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.

161. Therefore it is my opinion that Orametrix in view of Faul renders obvious ” wherein the 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,” as recited by this claim element.

10. Claim 15 Is Rendered Obvious by Orametrix and Faul

162. It is my opinion that Orametrix and Faul renders this claim obvious.

- 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.”**

163. Orametrix describes allowing for real-time viewing of a three-dimensional image of the scanned object. Ex-1005 at 34:12-15. Faul also describes rendering the geometry of a three-dimensional object in real-time. Ex-1004 at 8:56-

60.

164. Therefore, it is my opinion that Orametrix and Faul render obvious “wherein the hardware processor processes the raw 3D data into data for the 3D geometry in real time,” as recited by claim 15.

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

165. It is my opinion that Orametrix in view of Faul and Knighton teaches the elements of this claim.

- 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.”**

166. Orametrix describes the direct measurement of anatomical structures, including teeth. Ex-1005 at 56:11-20. Orametrix describes wirelessly communicating scanning data from the system to a client. *Id.* at 58:21-59:13; Fig. 44. This client may be, for example, design device 4415 at facility 4442, which is a workstation located remotely from scanner 4401. *Id.* 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. *Id.* at 58:1-14. Orametrix also describes an embodiment where probable movement of the scanner in the X, Y, and Z directions is determined. *See, e.g., id.* at 37:11-38:13. This

movement data is used in the modeling process to perform registration between image frames. *Id.* at 38:18-41:9. Given this disclosure, it is my opinion that a POSITA would understand that Orametrix's scanner would be wireless and communicating data wirelessly for remote processing.

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

168. As described above in Section IX.D, 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, e.g.*, Ex-1008 at [0044]. *See also id.* at [0033], [0045] (describing wireless configurations). Knighton further discloses that position and movement data may be generated by these sensors. *Id.* 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. *Id.* at [0080], [0082].

169. In my opinion 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.

170. Furthermore, it is my opinion that 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.

171. Therefore, it is my opinion that Orametrix in view of Faul and Knighton teaches “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,” as recited by claim 16.

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

172. It is my opinion that Orametrix in view of Faul and Knighton render this claim obvious.

- 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.”**

173. As discussed in Sections IX.A and X.A.1.h, Orametrix describes using probable scanner position for registering and stitching partial scans of the object to create an integrated surface map of the object. Furthermore, as discussed in Section X.A.1.h, 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.

174. Therefore, it is my opinion that Orametrix in view of Faul and Knighton renders obvious “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,” as recited by claim 18.

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

175. It is my opinion that Orametrix in view of Faul and Breton teaches the elements of this claim.

- 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.”**

176. As discussed above in Section X.A.1.i, Orametrix in view of Faul and Breton teaches changing colors of the projected structured light pattern. 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. Breton also teaches the advantages of limiting the color band analysis to the red, blue, and green color bands to conserve processing resources. *Id.* at 11:21-27. It is my opinion that 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.

177. Thus, it is my opinion that Orametrix in view of Faul and Breton renders obvious “wherein the light source further comprises at least three monochromatic light sources of the light source configured to provide the different colors,” as recited by claim 19.

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

178. It is my opinion that Orametrix in view of Faul and Breton renders this claim obvious.

- 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.”**

179. As discussed above in Sections IX.C, X.A.1.i, X.A.13, 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. It is my opinion that 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.

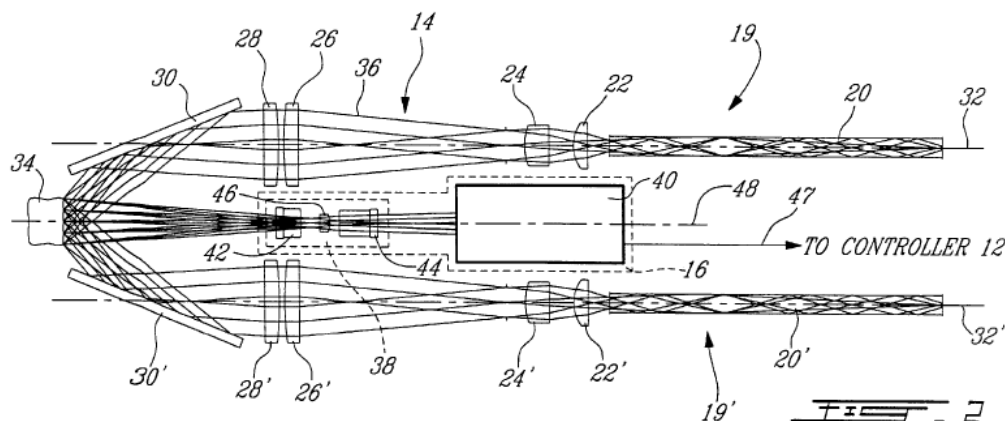
180. Thus, it is my opinion that Orametrix in view of Faul further in view of Breton renders “wherein the hardware processor is configured to selectively switch the color of the probe light by switching on and off the at least three monochromatic light sources,” as recited by claim 20.

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

181. It is my opinion that Orametrix in view of Faul and Breton renders this claim obvious.

- 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.”

182. 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:



183. Breton also describes directing the measurement illumination from integrator rod 20 towards tooth surface 34 using mirror 30. Ex-1003 at 4:1-26. Breton teaches that this configuration minimizes specular reflection. *Id.* at 4:19-26. Breton also teaches that other illumination and mirror configurations could be utilized. *Id.* It is my opinion that 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.

184. Therefore, it is my opinion that Orametrix in view of Faul further in view of Breton renders obvious, “wherein the probe light is directed towards the object in a direction substantially parallel with the longitudinal axis of the tip, and wherein the probe light is further reflected towards the object by a single reflective mirror located in the tip,” as recited by claim 22.

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

185. As discussed below, it is my opinion that the combination of Orametrix, Faul, Breton, and Knighton render the elements of claim 26 obvious.

a. [Claim 26pre]: “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:”

186. As discussed above in Section VIII.A, I have been informed that the District Court determined that the preamble of claim 26 is not limiting. Nevertheless, it is my opinion that 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.

Orametrix further teaches that the scanner would be held by a user, for example, a user in a home setting. *See, e.g., id.* at 58:1-14.

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

187. It is my opinion that Orametrix teaches this claim element. Orametrix describes a scanning device 4401 that shows a tip, as illustrated in Figure 44:

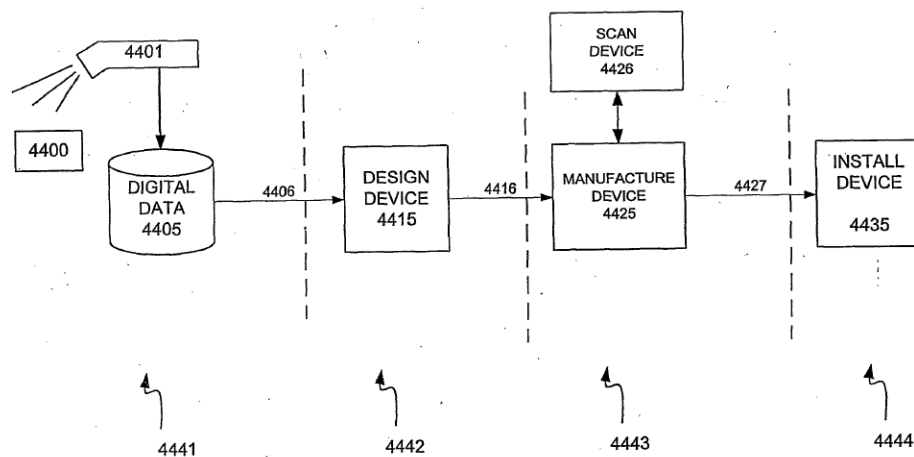


FIGURE 44

188. 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). It is my opinion that the scanner illustrated in Figure 44, in combination with the description of direct scanning of anatomical structures teaches the claimed “tip” limitation. Furthermore, it is my opinion that 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.

189. Therefore, it is my opinion that Orametrix renders obvious “a tip configured to be inserted into the oral cavity,” as recited by this element of claim 1.

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

190. It is my opinion that Orametrix teaches this limitation and therefore renders it obvious. 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 id.* at 4:3-10; 16:6-13; 34:4-6. It is my opinion that a POSITA would understand the camera/viewer of Orametrix would necessarily include an array of sensor elements.

191. Therefore, it is my opinion that Orametrix renders obvious “at least one camera accommodating an array of sensor elements,” as recited by this claim element.

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;”

192. It is my opinion that Orametrix and Faul each teaches this claim limitation and therefore renders it obvious. 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. System controller 951 provides specific information to scanner 980 specifying a specific image to be projected onto surface 991 of object 990. *Id.* at 15:19-21. Orametrix describes that the image to be projected can be a digital image that is stored in memory by data processor 952. *Id.* at 17:11-19. Orametrix further describes that in the scanning process, different patterns can be projected over different periods of time. *Id.* at 29:8-19; Figs. 16, 19, 23. 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.*

193. 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. Faul describes generating the time-varying pattern with a digital video projector. *Id.* at 4:25-53; 5:52-57. Faul discloses that the scanner includes a microprocessor and memory, *id.* at 7:64-8:8, and it is my opinion that 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.

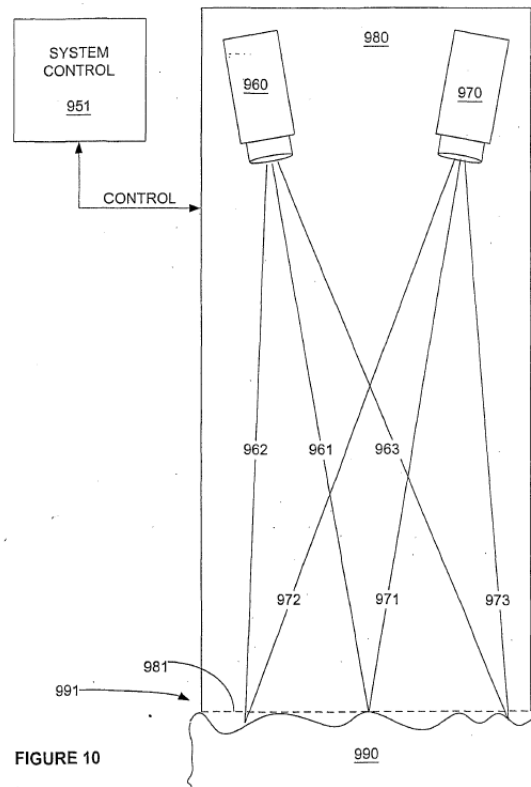
194. It is my opinion that a POSITA would have considered the digital image projection of Orametrix or Faul's projected pattern of structured light to be "a probe

light with a plurality of configurations in the form of a time-varying illumination pattern,” as claimed. Thus, it is my opinion that Orametrix and Faul each teaches, and therefore renders obvious “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,” as recited in claim 26.

- 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 . . .”**

195. It is my opinion that Orametrix and Faul each teaches this limitation.

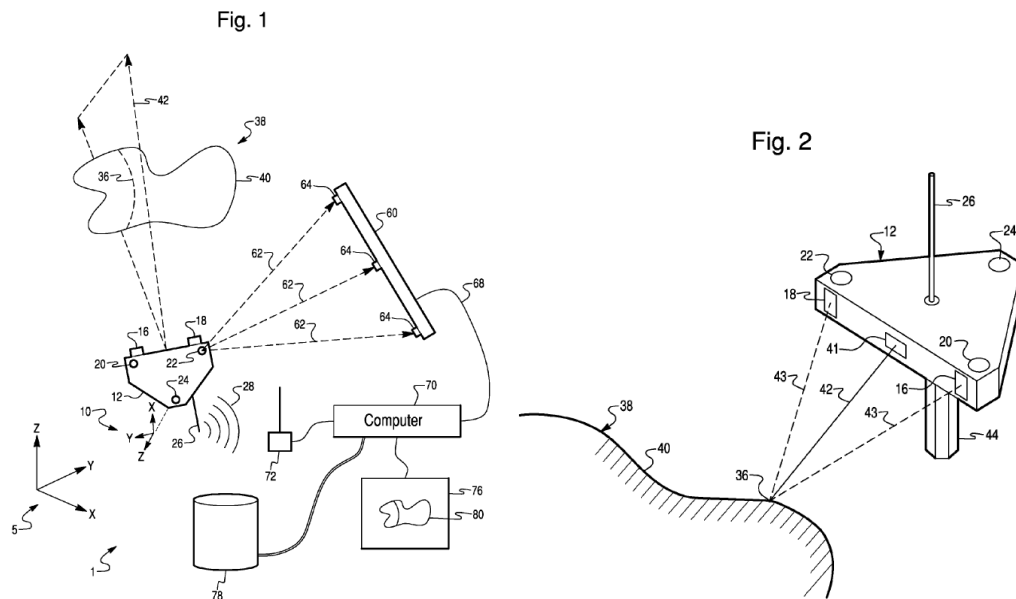
Figure 10 of Orametrix illustrates an optical system according to this claim element:



196. 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. The reflected light from the object is detected by viewing device 970. *Id.* Orametrix further describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. *Id.* at 30:7-8. The 2D image frames are then converted into three dimensions using conventional 3D imaging techniques. *Id.* at 30:8-12. *See also id.* at 75 (claim 4). Also, as discussed above in

Sections X.A.1.b and X.A.9.b, it is my opinion that a POSITA would understand that the scanner of Orametrix would have a tip for directing the scanning illumination towards a tooth in a mouth.

197. It is my opinion that Faul also describes the elements of this claim limitation. Figures 1 and 2 of Faul illustrate the claimed optical system:



198. 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. 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. *Id.* at 4:59-9:25; 7:11-29.

199. It is my opinion that 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. Therefore, it is my opinion that Orametrix and Faul each renders this claim element obvious.

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,"

200. It is my opinion that both Orametrix and Faul each renders this claim limitation obvious.

201. As discussed above in Section X.A.1.f, Orametrix describes that light projected by projector 960 reflected from the surface of object 990 is detected by viewing device 970. Ex-1005 at 16:6-13; Fig. 10.

202. 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.

203. It is my opinion that 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. Therefore, it is my opinion that Faul and Orametrix each renders this claim element obvious.

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

204. It is my opinion that both Orametrix and Faul each renders this claim limitation obvious.

205. As discussed above in Section X.A.1.e, Orametrix describes that the scanner receives a projected frame pattern that is digitized into a 2D image frame. *Id.* at 30:7-8. The 2D image frames are then converted into three dimensions using conventional 3D imaging techniques. *Id.* at 30:8-12. *See also id.* at 75 (claim 4).

206. 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.

207. It is my opinion that 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. Therefore, it is my

opinion that Orametrix and Faul each renders this claim element obvious.

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

208. It is my opinion that Orametrix in view of Faul and Knighton teaches this claim element. Orametrix describes the direct measurement of anatomical structures, including teeth. Ex-1005 at 31:11-19; 56:11-20. Orametrix describes wirelessly communicating scanning data from the system to a client. *Id.* at 58:21-59:13; Fig. 44. This client may be, for example, design device 4415 at facility 4442, which is a workstation located remotely from scanner 4401. *Id.* See also *id.* at 62:19-21; 63:11-18 (describing facility 4442). 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. *Id.* at 58:1-14. Orametrix also describes an embodiment where probable movement of the scanner in the X, Y, and Z directions is determined. See, e.g., *id.* at 37:11-38:13. This movement data is used in the modeling process to perform registration between image frames. *Id.* at 38:18-41:9. Given this disclosure, and in light of the descriptions of the wireless scanners in Faul and Knighton, it is my opinion that a POSITA would understand that Orametrix’s scanner would be wireless and communicating data wirelessly for remote processing.

209. Faul explicitly teaches the advantages of a wireless handheld scanner for obtaining scanning data of three dimensional 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. 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., id.* at 8:45-60. This position data is used to generate a set of 3D surface point coordinates that are used to model the scanned objects surface in three dimensions. *See, e.g., id.* at 3:11-24; 9:27-60.

210. As described above in Section IX.D, 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, e.g.*, Ex-1008 at [0044]. *See also id.* at [0033], [0045] (describing wireless configurations). Knighton further discloses that position and movement data may be generated by these sensors. *Id.* 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. *Id.* at [0080], [0082].

211. In my opinion 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.

212. Furthermore, it is my opinion that 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.

213. Therefore, it is my opinion that Orametrix in view of Faul and Knighton teaches “one or more motion sensors located on the intraoral scanner to measure three-dimensional motion of the intraoral scanner,” as recited by this claim element.

- 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”**

214. It is my opinion that Orametrix or Faul further in view of Breton teaches this claim element. As described above in Section X.A.1.c, Orametrix describes scanning the object surface with a time-varying pattern to determine shape information. 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. 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. *Id.* at 64:6-15. Orametrix teaches that the measurement techniques may be implemented and executed by a hardware processor as part of the system. *See, e.g., id.* at 16:19-22; 64:6-15; 69:15-70:10; Fig. 46.

215. Faul also describes projecting a time-varying pattern to determine the shape of an object. *See* Ex-1004 at 4:36-53. Faul describes that the time-varying pattern can be generated a digital video projector. *Id.* at 4:25-53; 4:36-52; 5:52-57. Faul also describes measuring the color of the scanned surface. *See, e.g., id.* at 6:60-67. Faul also describes dynamically altering the color of the projected structured light. *See id.* 10:64-11:4. Faul discloses that the scanner includes a microprocessor, *id.* at 7:49-8:8, and it is my opinion that 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.

216. 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. 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.* 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. *Id.* at 8:24-36.

217. In my opinion, 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. As discussed above 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. And as discussed above, Faul itself teaches color measurement and suggests dynamically changing the color of the projected time-varying structured light. It is my opinion that 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.

Thus, it is my opinion that Orametrix or Faul, further in view of Breton, teaches “a hardware processor located within the wireless intraoral scanner, configured to: selectively switch a color of the probe light, thereby illuminating the object with different colors at different times,” as recited by this claim element.

- 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.**

218. It is my opinion that Orametrix or Faul further in view of Breton teaches this claim element. As discussed above in section X.A.1.c, both Orametrix and Faul teach recording images of the scanned surface at different times with different projected patterns. For example Orametrix describes that the data may be a composite of scans taken at different times. Ex-1005 at 57:7-16. Likewise, Faul describes assigning timestamps to each scanned image. Ex-1004 at 14:7-39. Faul also describes recording images of the object with different colors. *Id.* at 12:20-30; Fig. 4 (describing data format 403 that includes RGB color intensities for each point in the image). As discussed above in Section X.A.1.h, it is my opinion that 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. 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.

219. Thus, it is my opinion that Orametrix or Faul in view of Breton teaches “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 on camera at the different times,” as recited by this claim element.

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

220. It is my opinion that the combination of Orametrix, Faul, and Knighton render this claim obvious.

- 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.”**

221. As discussed in Sections IX.A and X.A.8, Orametrix describes using probable scanner position for registering and stitching partial scans of the object to create an integrated surface map of the object. Furthermore, as discussed in Sections X.A.1.h, 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.

222. Therefore, it is my opinion that Orametrix in view of Faul and Knighton renders obvious “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,” as recited by claim 28.

18. Claim 29 Is Rendered Obvious by Orametrix in View of Faul

223. It is my opinion that Orametrix in view of Faul renders this claim obvious.

- 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.”**

224. As discussed above in Section X.A.1.g, Orametrix and Faul describe determining the 3D geometry based on the plurality of 2D images.

225. 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. Faul describes that subpixel coordinates of given points on the scanned 2D images are transformed into three-dimensional coordinates that are then transmitted. *Id.* at

12:27-32. Faul specifically describes this local processing as significantly reducing the amount of transmitted geometric and color data, as compared to conventional transmission. *Id.* at 12:43-50. It is my opinion that 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, as discussed in Section X.A.1.h, the combination of Orametrix and Faul teaches wireless transmission of the scanner data. It is my opinion that 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.

226. Therefore it is my opinion that Orametrix in view of Faul renders obvious ” 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,” as recited in claim 29.

XI. CONCLUSION

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

Dated: August 16, 2023

By: Rongguang Liang