

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DENTAL IMAGING TECHNOLOGIES CORPORATION,
Petitioner

v.

3SHAPE A/S,
Patent Owner

U.S. Patent No. RE48,221 to Öjelund *et al.*
Issue Date: September 22, 2020
Title: SYSTEM WITH 3D USER INTERFACE INTEGRATION

DECLARATION OF MR. KURTIS KELLER
IN SUPPORT OF INTER PARTES REVIEW OF RE48,221

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	QUALIFICATIONS AND EXPERTISE	5
III.	LEGAL UNDERSTANDING	7
	A. Person of Ordinary Skill in the Art	10
IV.	BACKGROUND OF THE TECHNOLOGY DISCLOSED IN THE '221 PATENT	11
	A. Three Dimensional Intraoral Scanning with Human-Computer Interfaces and Motion Sensing Was Well Known	11
V.	THE '221 PATENT	27
	A. Overview	27
	B. Summary of Prosecution History	30
VI.	CLAIM CONSTRUCTION	34
VII.	OVERVIEW OF GROUNDS ASSERTED IN THE PETITION AND PRIOR ART	35
	A. Overview of Gattani	36
	B. Overview of Kriveshko	39
	C. Overview of Serra	41
	D. Overview of Hopkins	44
	E. Overview of Marvit	46
	F. Overview of Wilson	49
	G. Overview of Quaid	50
VIII.	GROUND 1: CLAIMS 1, 5, 9, 18, 22-26, 28, 31, AND 33 ARE ANTICIPATED BY GATTANI	51
	A. Claim 1	51

B.	Claim 5	64
C.	Claim 9	65
D.	Claim 18	66
E.	Claim 22	66
F.	Claim 23	70
G.	Claim 24	70
H.	Claim 25	71
I.	Claim 26	72
J.	Claim 28	72
K.	Claim 31	75
L.	Claim 33	77
IX.	GROUND 2: CLAIMS 1-3, 5-7, 9-11, 15, 18-21, 23-28, 31-34, 40-44 ARE OBVIOUS OVER KRIVESHKO, SERRA, AND HOPKINS	79
A.	Claim 1	79
B.	Claim 2	94
C.	Claim 3	95
D.	Claim 5	97
E.	Claim 6	98
F.	Claim 7	101
G.	Claim 9	102
H.	Claim 10	103
I.	Claim 11	107
J.	Claim 15	108

K.	Claim 18	111
L.	Claim 19	112
M.	Claim 20	114
N.	Claim 21	114
O.	Claim 23	115
P.	Claim 24	117
Q.	Claim 25	117
R.	Claim 26	118
S.	Claim 27	119
T.	Claim 28	119
U.	Claim 31	120
V.	Claim 32	122
W.	Claim 33	124
X.	Claim 34	127
Y.	Claim 40	128
Z.	Claim 41	131
AA.	Claim 42	131
BB.	Claim 43	132
CC.	Claim 44	133
X.	GROUND 3: CLAIM 22 IS OBVIOUS OVER KRIVESHKO, SERRA, HOPKINS, AND WILSON.....	134
A.	Claim 22	134

XI.	GROUND 4: CLAIM 30 IS OBVIOUS OVER KRIVESHKO, SERRA, HOPKINS, AND QUAID	137
A.	Claim 30	137
XII.	GROUND 5: CLAIMS 1-3, 5-7, 9-11, 15, 19-21, 21-28, 31-34, AND 40-44 ARE OBVIOUS OVER KRIVESHKO, SERRA, AND MARVIT.....	139
A.	Claim 1	139
B.	Claim 2	143
C.	Claim 3	144
D.	Claim 5	144
E.	Claim 6	145
F.	Claim 7	146
G.	Claim 9	147
H.	Claim 10	147
I.	Claim 11	148
J.	Claim 15	148
K.	Claim 19	149
L.	Claim 20	151
M.	Claim 21	151
N.	Claim 22	152
O.	Claim 23	153
P.	Claim 24	154
Q.	Claim 25	154
R.	Claim 26	154

S.	Claim 27	155
T.	Claim 28	155
U.	Claim 31	156
V.	Claim 32	156
W.	Claim 33	158
X.	Claim 34	160
Y.	Claim 40	160
Z.	Claim 41	161
AA.	Claim 42	162
BB.	Claim 43	162
CC.	Claim 44	163
XIII.	GROUND 6: CLAIM 30 IS OBVIOUS OVER KRIVESHKO, SERRA, MARVIT, AND QUAID	164
A.	Claim 30	164

I. INTRODUCTION

1. I, Mr. Kurtis Keller, declare as follows:

2. I am over 18 years of age. I have been retained as an expert witness by Foley & Lardner, LLP to provide testimony on behalf of Dental Imaging Technologies Corporation, (“DITC” or “Petitioner”) for the above-captioned *inter partes* review proceeding. This Declaration concerns prior art and technical subject matter related to the *inter partes* review petition (“Petition”) concerning U.S. Patent No. RE48,221 (“the ’221 patent”) titled “System With 3D User Interface Integration” to Henrik Öjelund, et al. It is my understanding that the ’221 patent is currently assigned to 3Shape A/S (“3Shape” or “Patent Owner”).

3. I am familiar with the following materials:

Exhibit	Description
1001	U.S. Patent No. RE48,221 to Öjelund et al.
1002	File History of U.S. Patent No. RE48,221 (“Prosecution History”)
1003	Declaration of Dr. Kurtis Keller (“Keller Decl.”) in support of Petition for <i>Inter Partes</i> Review of U.S. Patent No. RE48,221
1004	<i>Curriculum Vitae</i> of Dr. Kurtis Keller
1005	Öjelund Provisional, U.S. Provisional Application No. 61/420,138 (filed December 6, 2010)
1006	A Comparative Analysis of Intraoral 3D Digital Scanners For Restorative Dentistry, by Logozzo et al. (“Logozzo”), published January, 2011.
1007	Ireland et al., “3D surface imaging in dentistry – what we are looking at,” British Dental Journal, Vol. 205, No. 7, October 11, 2008.
1008	U.S. Patent No. 6,485,413 to Boppart et al.

1009	Johnny Chung Lee, "Hacking the Nintendo Wii Remote," IEEE CS, 2008.
1010	Hajeer et al., "Current Products and Practices Applications of 3D imaging in orthodontics: Part II," Journal of Orthodontics, Vol. 31, No. 2, June 2004.
1011	U.S. Patent No. 6,592,371 to Durbin et al.
1012	U.S. Patent No. 5,722,412 to Pflugrath et al.
1013	U.S. Patent No. 6,645,148 to Nguyen-Dinh et al.
1014	Brad A. Myers, <i>CRC Handbook of Computer Science and Engineering</i> , 2d. Ed., Allen B. Tucker, January 27, 2003, "Graphical User Interface Programming"
1015	Foley et al., <i>Introduction to Computer Graphics</i> , Addison-Wesley, 1994, "Chapter 2.2: Basic Interaction Handling", "Chapter 6: Viewing in 3D", and "Chapter 8: Input Devices, Interaction Techniques, and Interaction Tasks"
1016	Donald Hearn and M. Pauline Baker, <i>Computer Graphics</i> , 2d. Ed., Prentice Hall, 1994, "Chapter 2: Overview of Graphics Systems", "Chapter 8: Graphical User Interfaces and Interactive Input Methods", and "Chapter 9: Three-Dimensional Concepts"
1017	U.S. Patent No. 5,181,181 to Glynn
1018	U.S. Patent Publication No. 2006/0092133 to Touma et al.
1019	Bornik et al., "A Hybrid User Interface for Manipulation of Volumetric Medical Data," 3DUI '06: IEEE Symposium on 3D User Interfaces, March 2006.
1020	U.S. Patent Publication No. 2010/0009308 to Wen et al.
1021	Greg Welch and Eric Foxlin, "Motion Tracking: No Silver Bullet, but a Respectable Arsenal," IEEE Computer Graphics and Applications, Vol. 22, No. 6, December 10, 2002.
1022	Hannes Kaufmann, "Applications of Mixed Reality," Thesis, Vienna University of Technology, May 27, 2009.
1023	Ferreira, Joao Filipe, Jorge Lobo, and Jorge Dias. "Tele-3D-Developing a Handheld Scanner Using Structured Light Projection." 3DPVT. 2002.
1024	Ueda, Tatsuro, et al. "Visual information assist system using 3D SOKUIKI sensor for blind people, system

	concept and object detecting experiments." IECON 2006-32nd Annual Conference on IEEE Industrial Electronics. IEEE, 2006.
1025	U.S. Patent No. 4,342,227 to Petersen et al.
1026	U.S. Patent No. 5,563,343 to Shaw et al.
1027	Steven Nasiri, "A Critical Review of MEMS Gyroscopes Technology and Commercialization Status," InvenSense, 2005.
1028	U.S. Patent Publication No. 2008/0070684 to Haigh-Hutchinson
1029	U.S. Patent Publication No. 2013/0110469 to Kopelman
1030	U.S. Patent Publication No. 2012/0062557 to Dillon et al.
1031	U.S. Patent Publication No. 2007/0031774 to Cinader, Jr. et al.
1032	U.S. Patent No. 9,329,675 to Öjelund et al.
1033	<i>Inter Partes</i> Review Certificate, U.S. Patent No. 9,329,675 K1 to Öjelund et al.
1034	Final Written Decision for <i>Inter Partes</i> Review of U.S. Patent No. 9,329,675 in IPR2018-00197, May 29, 2019.
1035	Giammanco et al., "Using 3D Laser Scanning Technology to Create Digital Models of Hailstones," American Meteorological Society, July 2017.
1036	Orhan H. Karatas and Ebubekir Toy, "Three-dimensional imaging techniques: A literature review," European Journal of Dentistry, Vol. 8, No. 1, March 2014.
1037	B. H. Broadbent, "A New X-Ray Technique and Its Application to Orthodontia," The Angle Orthodontist, Vol. I, No. 2, February 4, 1931.
1038	'221 Patent Notice of Allowance
1039	Nathan S. Birnbaum and Heidi B. Aaronson, "Dental impressions using 3D digital scanners: virtual becomes reality," Compend. Contin. Educ. Dent., Vol. 29, No. 8, October 2008.
1040	U.S. Patent No. 6,227,850 to Chishti et al.
1041	Steele et al., "Bodies in motion: Monitoring daily activity and exercise with motion sensors in people with chronic pulmonary disease," J. Rehabil. Res. Dev., Vol. 40, No. 5, Suppl. 2, October 2003.

1042	Hale et al., “Measuring free-living physical activity in adults with and without neurologic dysfunction with a triaxial accelerometer,” Arch. Phys. Med. Rehabil., Vol. 89, No. 9, September 2008.
1043	Daniel Turner, “Hack: The Nintendo Wii,” MIT Technology Review, July 1, 2007.
1105	U.S. Patent Publication No. 2008/0071143 (“Gattani”)
1106	U.S. Patent Publication No. 2007/0171220 (“Kriveshko”)
1107	U.S. Patent Publication No. 2006/0020204 (“Serra”)
1108	U.S Patent No. 8,914,245 (“Hopkins”)
1109	U.S. Patent Publication No. 2005/0212756 (“Marvit”)
1110	U.S. Patent Publication No. 2005/0110751A1 (“Wilson”)
1111	U.S. Patent Publication No. 2006/0142657 (“Quaid”)
1112	Hopkins Provisional Application No. 61/161,910

4. Each of the Exhibits listed above are, to the best of my knowledge, true and accurate copies of what they purport to be. The materials listed above are the kinds of materials that an individual with expertise in this field would reasonably rely on in formulating opinions, such as those set forth in this declaration.

5. I have been asked to provide my expertise and opinions regarding the '221 patent and the references that form the basis for the Grounds set forth below regarding claims 1-3, 5-7, 9-11, 15, 18-28, 30-34, and 40-44 of the '221 patent (the “Challenged Claims”). The '221 patent is directed to “a system comprising a handheld device and at least one display . . . [t]he handheld device is adapted for performing at least one action in a physical 3D environment.” EX1001, '221 patent, Abstract. I was at least a person of ordinary skill in the art (“POSA”) with regard to

the technology described in the '221 patent, and likely much more, as of its PCT filing date of December 5, 2011, and its asserted December 6, 2010, priority date.

II. QUALIFICATIONS AND EXPERTISE

6. I am qualified by education and expertise to testify as an expert in the field of 3D medical imaging and more specifically in its application to dental imaging. My background is outlined in my curriculum vitae. EX1004.

7. In 1988, I earned a Bachelor's of Science degree in Mechanical Engineering from North Carolina State University, and, in 1994, a Master's Degree in Integrated Manufacturing Systems Engineering, also from North Carolina State University. Since obtaining my Master's Degree, I have taken post graduate coursework in Optics from the University of North Carolina and the University of Arizona.

8. In 2003 I co-founded InnerOptic Technology Inc., and have served as the company's Optical/Mechanical Engineering Director & Chief Operating Officer for the over 15 years. InnerOptic Technology develops image navigation solutions for medical applications. These solutions include, for example: AimTM, an FDA-cleared ultrasound needle navigation solution that reduces spatial coordination problems inherent in ultrasound-guided medical interventions; Magic LoupeTM, a suite of three-dimensional ("3D") image visualization and navigation tools in a mix-

reality application interface; and SpotlightTM, a solution that performs sensor fusion of CT and ultrasound images, and allows for 3D navigation of the fused image set.

9. Over my career, I have published over twenty-six academic papers, most of which relate to 3D image reconstruction, visualization, and navigation with most relating to assisting or improving medical procedures. Likewise, I have been granted twelve U.S. patents, and have an additional six patents pending; most of which relate to 3D image reconstruction, visualization, and navigation.

10. My experience includes real-world attempts to build 3D imaging solutions involving 3D image reconstruction, visualization, and navigation. For example, I have been engaged on over thirty such projects by universities, national and international governmental agencies, and private industry. These projects include: a miniature laser projector for 3D depth extraction and imaging for endoscopic surgery, and a 6DOF magnetic tracker system with mounts and graphic feedback for registration of dental implants across a jaw. I was the principal investigator on two National Science Foundation grants related to 3D laparoscope technology.

11. Over my career I have been actively involved as a reviewer or engaged in panel activities for the World Society for Computer Graphics, the International Symposium on Mixed and Augmented Reality, the National Institute of Health, and the National Science Foundation.

12. I have served as an expert witness on matters related to optics, imaging, image visualization, and human machine interface technologies.

III. LEGAL UNDERSTANDING

13. I have been advised by counsel for Petitioner that certain legal standards must be applied by technical experts in my opinions regarding the proper meaning of patent claims and the validity of claims in view of the prior art. I am not an attorney, I am not providing any legal opinion, and I have relied on Petitioner's counsel for my understanding of the applicable legal standards.

14. I understand that the first step to determining the validity of a patent claim is comparing an asserted claim to the prior art is for the claim to be properly construed.

15. I understand that for a reference to anticipate a patent claim it must be prior art and it must disclose, either expressly or inherently, each limitation of a claim. I understand, that whether a reference discloses a particular claim limitation is to be judged from the perspective of a POSA.

16. I understand that claimed subject matter may be obvious in view of more than one or items of prior art. I understand, however, that it is not enough to show simply that all the limitations of the claimed subject matter are spread throughout the prior art. Instead, for claimed subject matter to be obvious over one

or more references, there must be some reason or motivation for a POSA to combine the prior art references to arrive at the claimed subject matter.

17. I have been informed that, in seeking to determine whether an invention that is a combination of known elements would have been obvious to a POSA at the time of the invention, one must consider the references in their entirety to ascertain whether the disclosures in those references render the combination obvious to such a person.

18. I have been informed and understand that, while not required, the prior art references themselves may provide a teaching, suggestion, motivation, or reason to combine, but other times the motivation linking two or more prior art references is common sense to a POSA at the time of the invention.

19. I understand that a particular combination may be proven obvious merely by showing that it was obvious to try the combination. I have been informed that, if a technique has been used to improve one device, and a POSA 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.

20. I further understand that an obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references also may be supplied by the direction of the marketplace. 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 POSA has good reason to pursue the known options within his or her technical grasp because the result is likely the product not of innovation but of ordinary skill and common sense.

21. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. Thus, where all of the elements of a claim are used in substantially the same manner, in devices in the same field of endeavor, the claim is likely obvious.

22. Additionally, I understand that a patent is likely to be invalid for obviousness if a POSA can implement a predictable variation or if there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. Therefore, 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 one.

23. I further understand that combining embodiments related to each other in a single prior art reference would not ordinarily require a leap of inventiveness.

24. I also understand that a POSA must have had a reasonable expectation of success when combining references for claimed subject matter to be obvious.

25. I have been informed and I understand that factors referred to as “objective indicia of non-obviousness” or “secondary considerations” are also to be considered when assessing obviousness when such evidence is available. I understand that these factors can include: (1) commercial success; (2) long-felt but unresolved needs; (3) copying of the invention by others in the field; (4) initial expressions of disbelief by experts in the field; (5) failure of others to solve the problem the claimed subject matter solved; and (6) unexpected results.

26. Finally, I have been informed that one cannot use hindsight to determine that an invention was obvious.

27. I provide my opinions in this Declaration based on the guidelines set forth above.

A. Person of Ordinary Skill in the Art

28. I have been informed and understand that the level of ordinary skill in the relevant art at the time of the invention is relevant to inquiries such as the meaning of claim terms, the meaning of disclosures found in the prior art, and the reasons a POSA may have for combining references.

29. I have been informed and understand that factors that may be considered in determining the level of ordinary skill include: (1) the education of the inventor; (2) the type of problems encountered in the art; (3) prior art solutions to those problems; (4) rapidity with which innovations are made; (5) sophistication of

the technology; and (6) education level of active workers in the relevant field. I have been further informed and understand that a POSA is also a person of ordinary creativity. I have been asked to consider the level of ordinary skill in art possessed by a POSA at the time the claimed invention was made. In deciding the level of ordinary skill, I considered: level of education and experience of people working in the field; the types of problems they encountered; and the sophistication of the technology.

30. Based on the disclosure of the '221 patent, a POSA would have a bachelor's degree in Computer Engineering, Computer Science, Computer Vision, or an equivalent field, as well as at least one or two years of industry experience, or at least five years of comparable industry experience. In particular, a POSA would have had experience with and knowledge of 3D imaging systems and 3D modeling techniques.

IV. BACKGROUND OF THE TECHNOLOGY DISCLOSED IN THE '221 PATENT

A. Three Dimensional Intraoral Scanning with Human-Computer Interfaces and Motion Sensing Was Well Known

1. Handheld Three Dimensional (3D) Digital Scanning Was Well Known.

31. 3D scanning refers to methods for acquiring 3D surface or volumetric data of an object based on moving a 3D measurement system across a two-dimensional field, such as a body part or a tooth. Research into accurate

measurements such objects began in the 1960s. EX1035, Giammanco, at 1341-42. Dr. Francios Duret introduced the 3D measurement and modelling of dental objects to field of dentistry in the 1970s. EX1006, Logozzo, at 1.

32. Generally, handheld 3D scanning involves measuring the surface geometry of a 3D object by acquiring multiple data points on the surface of the target as the handheld scanner passes over it and generating a 3D computer model based on those data points. Various methods of 3D dental scanning has been performed for years with multiple commercially available devices. EX1006, Logozzo (surveying 3D dental scanning methods available in 2011).

33. Once a 3D model is generated, a display of the 3D model may be generated on a computer screen and interactively used for, *e.g.*, measurement, modeling, and simulation within the 3D environment. Common applications of this technique include archeology, 3D computer animation, topography, internal medicine, dentistry, rapid prototyping, and reconstructive and plastic surgery.

34. One characteristic of a handheld 3D scanner is its non-contact operation. “Non-contact” handheld 3D scanners do not make physical contact with the surface of the target being scanned. EX1007, Ireland, at 388-89. Instead, non-contact handheld 3D scanners detect the reflection or absorption of radiation off of the surface of the target. *Id.* In typical applications, the handheld 3D scanner actively projects radiation to determine the deflection location at the surface of the target.

This radiation may be light, ultrasound, or x-ray. EX1008, Boppart, at 1:55-59. Alternatively, handheld 3D scanners may not emit radiation, and instead detect reflected ambient radiation.

35. Dental imaging technology was first developed in the late 1800s after the discovery of x-rays by W.C. Roentgen. EX1036, Karatas, at 133. Decades later, developers produced standard methods of producing cephalometric radiographs and these were introduced to dental specialists by Broadbent and Hofrath in 1931. EX1037, Broadbent, at 45-66. Still later, in the 1970s, and as mentioned above, Duret presented a thesis introducing computer aided design/computer aided manufacturing (CAD/CAM) concepts for dental applications, culminating in the 1980s with a CAD/CAM system capable of fabricating a dental crown in 4 hours. EX1006, Logozzo, at 1.

36. Digital impressions have thus been introduced and successfully used for decades in orthodontics, but the first intraoral scanner for restorative dentistry was by Mormann and Brandestini in the 1980s. Mormann and Brandestini introduced a CAD/CAM system that included one of the earliest, if not the earliest, intraoral scanner. EX1039, Birnbaum, at 0003-06; EX1006, Logozzo, at 1.

37. Handheld 3D introral scanning technology has only improved since Mormann and Brandestini's early application. These systems are capable of capturing 3D virtual images of tooth preparations and using those images for

accurate master models for directly fabricating restorations in a dental laboratory. EX1006, Logozzo, at 1.

38. By 2008, at least 10 such handheld 3D intraoral scanning devices were available all over the world. EX1006, Logozzo, at 1. These devices were designed to address disadvantages of traditional impression fabrication processes, such as mould instability, plaster pouring, laceration on margins, and geometrical and dimensional discrepancy between the die and the mould. EX1006, Logozzo, at 1. Prior to this technology, a 3D negative model of a patient's tooth was created using a physical mold casting procedure. EX1011, Durbin, at 2:15-33; EX1007, Ireland, at 388-89.

39. The main advantages of the handheld 3D intraoral scanning devices were the creation of high fidelity models, creation of 3D archives, surgery simulation, and process simplification. EX1006, Logozzo, at 1.

40. The handheld 3D intraoral scanning devices in existence before the earliest effective priority date of the '221 patent typically utilized non-contact optical technologies such as confocal microscopy, optical coherence tomography, photogrammetry, active and passive stereovision and triangulation, interferometry and phase shift principles.

41. All of these technologies were designed and known to minimize the noise source related to the scanning inside an oral cavity. *Id.* For example, optical

features of the target surfaces (translucency and differing reflectivity of the target material, including teeth, gums, preparations, resins, etc.), wetness, and random relative motions. *Id.* Several typologies of structured light sources were also employed at this time. *Id.*

42. One example of this technology is OraScanner, a handheld 3D intraoral scanner developed by OraMetrix Company by 1998. OraScanner uses a structured light technique, whereby a video camera records the structured light distortions on the dental crowns as it passes over the dentition in about one minute. The computer processes these images and merges them together to create a complete 3D dental arch. EX1010, Hajeer; *see also* EX1011, Durbin, Abstract, 1:11-14 (describing methods for generating 3D models using intraoral methods and apparatuses).

43. Another example of this technology is iTero, a handheld 3D intraoral scanner developed by 2007. EX1039, Birnbaum, at 0006-07; *see also* EX1006, Logozzo, at 4-6. iTero utilizes a handheld scanning device that utilizes confocal technology using red laser light patterns onto the surface of the target tooth, and converts the reflected light into digital data. EX1039, Birnbaum, at 0006-07. iTero further uses a computer that generates a 3D model of the target tooth based on the digital data and displays the 3D model on a display. EX1039, Birnbaum, at 0006-07. The operator is able to rotate the 3D model using a mouse. EX1039, Birnbaum, at 0006-07.



EX1006, Logozzo, at 5.

44. Around the same time, 3M ESPE introduced Lava Charside Oral Scanner. EX1006, Logozzo, at 8; EX1039, Birnbaum, at 0007-09. The Lava system included a mobile cart containing a CPU, a touch screen display, and a scanning wand. EX1006, Logozzo, at 8. In contrast to other techniques, the Lava system employed defocusing and shifting aperture locations to capture 3D data. EX1039, Birnbaum, at 0007-09. The generated 3D model would be displayed to the user via a computer monitor, and could be rotated using an input device. *Id.*



EX1006, Logozzo, at 8.

2. Human-Computer Interfaces for Navigating and Displaying 3D Environments Were Well Known.

45. As early as 1998, it has been known to incorporate user controls such as buttons and the like on scanners that are operable to adjust the functionality of the scanning device and computer graphics display of a 3D model on a computer monitor. EX1012, Pflugrath, Fig. 1; EX1013, Nguyen-Dinh, Figs. 2-6. Incorporating control functionality into a handheld scanning device to improve the comfort level of an operator of the scanning device was also known. EX1013, 4:20-25 (“[I]t would be appreciated that the provision of a pointing device such as a trackball or the like directly mounted on the ultrasonic probe will afford major gains in comfort and ease of use to the operator, who will now be able to easily and rapidly access these controls and, therefore, better attend to the patient.”).

46. To obtain a display or view of the scanned 3D geometry or environment, a user could use 3D graphics packages and standard 3D transformations to create moving reference views and coordinate space of a virtual camera. *See, e.g.*, EX1014, Myers; EX1015, Foley; EX1016, Hearn. To achieve this, the user would position and orient a virtual camera in the 3D space such that the virtual camera viewing plane (*e.g.*, a plane in which to display the view) faced the 3D model.

47. Typically, a virtual camera is controlled by a human-computer interface to accomplish a virtual viewing angle relative to the 3D model. The 3D model is

transformed to the virtual camera reference coordinates and projected onto the selected viewing plane. Lighting, texture mapping, and other graphical rendering techniques are used, depending on the selected viewing plane, to provide color shading of surfaces of the displayed 3D environment.

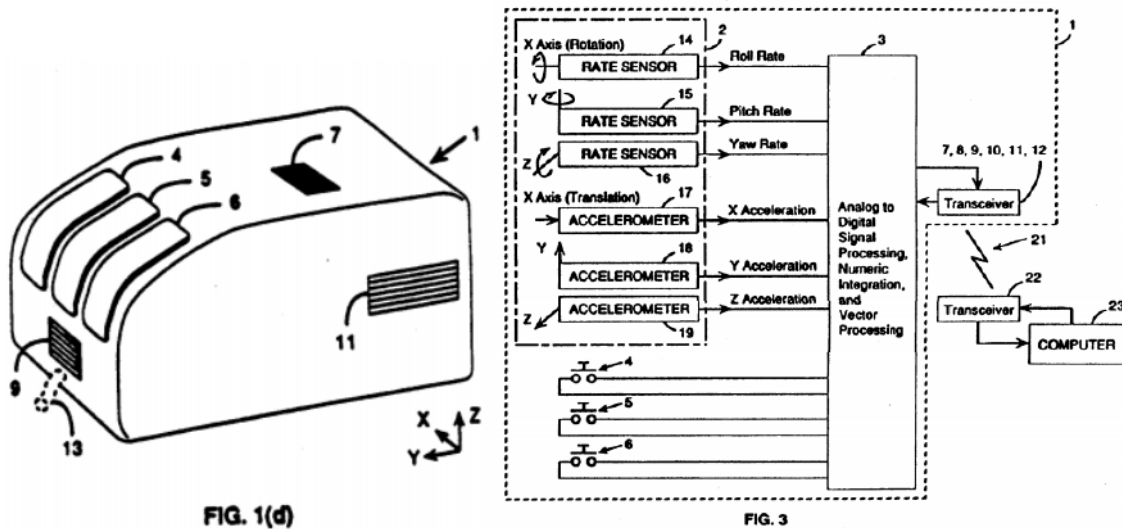
3. 3D Human-Computer Interfaces Including Motion Sensors Were Well Known, Including in Medical Fields.

48. Human-computer interaction includes design, evaluation, and implementation of interactive computing systems. Most such systems traditionally included a cursor, indicating position on a display. EX1021, Glynn, 1:13-22. Initial means of human-computer interaction comprised use of a keyboard, and later evolved to use of devices such as a mouse, trackball, joystick, or light pen. EX1021, Glynn, 1:23-30.

49. As use of computer applications increased, particularly to navigate and view generated 3D environments, the means of human-computer interaction with those environments expanded and manners of inputting and manipulating 3D position, orientation, and motion were developed. *Id.*, 1:42-57, 2:10-19. This was needed in computer applications including modeling, simulation, and animation of objections in 3D environments. *Id.*, 1:42-57, 2:10-19.

50. One exemplary patent from 1993 illustrates a 3D mouse with motion sensors. *Id.*, 2:10-19, 6:3-26. The 3D mouse sends position, motion, and orientation data in terms of 3D spatial coordinates. *Id.* As depicted below, the motion sensors,

which are described as “conventional” rotational rate sensors and accelerometers aligned on three orthogonal axes, provide sensor signals to the computer. *Id.* The computer uses those signals to manipulate a graphical representation of an object on a connected display. *Id.* at 3:66-4:6, Figs. 1(d), 3, 5-6, and 10.



Id. at Figs. 1(d), 3.

51. 3D models have long been employed in the field of medicine for diagnosis and treatment planning. EX1011, 2:10-33, 5:21-50. To interact with these 3D models, human-computer interfaces were used to display and manipulate the models. EX1019, Bornik, 0002-03 (“Related Work”).

52. Chishti teaches a computer “used to create a plan for repositioning an orthodontic patient’s teeth . . . receives a [3D] digital data set representing the patient’s teeth and uses the data set to generate one or more orthodontic views of the patient’s teeth.” EX1040, Chishti, at 1:50-54. In particular, “[a] 3D graphical

representation of the teeth at the positions corresponding to a selected data set can be rendered.” *Id.*, at 1:65-67. Further, “[a]n input signal from a 3D gyroscopic input device controlled by a human user can be used to alter the orientation of the teeth in the graphical representation.” *Id.*, 2:18-20.

53. Bornik describes “a novel system for interactive visualization and manipulation of medical datasets for surgery planning based on a hybrid VR / Tablet PC user interface. The goal of the system is to facilitate efficient visual inspection and correction of surface models generated by automated segmentation algorithms based on x-ray computed tomography scans, needed for planning surgical resections of liver tumors.” *Id.*, 0002 (“Abstract”). As illustrated in Figure 3, below, Bornik further discloses a handheld hybrid user input device that would be used for 2D and 3D medical tasks by combining the functionality of a 3D mouse and stylus pen. *Id.*, 0002 (“Introduction”), 0004 (“3.3. Hybrid Input Device”).



Id., Fig. 3.

54. Wen discloses a system for manipulating 3D dental models using hand gestures input through use of a glove which measures orientations, positions of hand gestures, or using a 3D mouse to manipulate the 3D digital dental model. EX1020, Wen, Abstract, ¶¶0014, 0024, 0061, 0062, 0064, 0066, 0067, 0076, Figs. 1, 2.

55. Tracking motion using integrated sensors has long been possible through use of small chip-based accelerometers and gyros, used for dynamic motion sensing and control. This understanding is evidenced in a variety of medical and interactive graphics applications. EX1009; *see also* EX1021, Welch-Foxlin. For example, Welch-Foxlin discloses: “Instrument tracking. Tracked tools and instruments let you match virtual computer graphics representations with their physical counterparts—for example, for computer-aided surgery or mechanical

assembly.” Welch-Foxlin further provides examples where motion sensors would be used for “augmented reality to assist with breast biopsy procedures,” to assist during “hip-replacement surgeries,” and to provide “head- and-hand tracking for projection-based interactive visualization.” *Id.*, 32-36, Figs. 7, 11-13.

56. The use of motion sensors such as accelerometers or gyros for position/orientation detection and data generation in handheld devices such a 3D scanner to manipulate a display was conventional within the medical field, video game controllers, as well as smart devices before the earliest possible priority date. *See, e.g.*, EX1009 (“Wiimote”), EX1021 (describing handheld device applications of motion sensing in 2002); EX1022 Kaufmann.

57. A 2002 paper discloses “the development of a fully portable, handheld system using cameras, projected structured light and attitude and positioning measuring sensors—the Tele-3D scanner.” EX1023, Ferreira, Abstract. The disclosed system uses gyroscopes and accelerometers to track the position of the disclosed 3D scanner. *Id.* at “3D Information Integration,” “System Architecture.”

58. Indeed, Microelectromechanical systems (“MEMS”) accelerometers and gyros were developed as early as the 1980s, and a compact accelerometer chip and/or gyro chip could easily be implemented in a variety of devices as evidenced in great detail above. *See, e.g.*, EX1025, Petersen; EX1026, Shaw; EX1027, Nasiri.

Accelerometers and gyroscopes are specific species of motion detecting devices of which there are many.

59. Using motion sensing technology to manipulate a display was widely understood and appreciated by computer graphics developers, as well as for applications of handheld 3D scanner tracking and tracking of other 3D scanners, full body motion capture, surgical instrument tracking, mixed and virtual reality, and camera tracking for media and entertainment. *See, e.g.*, EX1020; EX1021; EX1022; EX1023; EX1024. Some advantages of these systems included improved accuracy of a scan, and giving the user a more intuitive and direct way to interactively and remotely control or manipulate the views of a 3D environment on a display. EX1020; EX1021; EX1022; EX1023; EX1024.

60. Furthermore, continuous motion sensing technology provided by accelerometers and gyros to manipulate a display were widely understood and known. For example, the Wii Remote popularized this technology in 2005. *See, e.g.*, EX1009, Lee; EX1043, Turner; EX1044, Haigh-Hutchinson. The Wii Remote and its various attachments (*e.g.*, Nunchuk) allowed a user to interact with and manipulate items on a display by using gesture-based inputs derived from MEMS accelerometers and gyros and infrared optical technology within the devices. *Id.* The technology allowed a user to control a 3D viewpoint on the display based on signals

from optical and/or accelerometer sensors. *See* EX1044, Haigh-Hutchinson, ¶¶0002, 0008, 0078, Figs. 1, 5.

61. 3D graphics and graphical user interface programming were well understood and would easily be manipulated in a device or a system based on events generated by motion sensor position and orientation input data. *See, e.g.*, EX1008; EX1028; EX1014; EX1015; EX1016. Computer graphics programs were designed to use several forms of input data from various input devices, independent of the particular hardware input devices used for a particular application. *See, e.g.*, EX1015; EX1016.

62. For example, as implemented on the Wii Remote device, “acceleration sensor 507 may include an embedded signal processor or other type of dedicated processor for performing any desired processing of the acceleration signals output from the accelerometers therein prior to outputting signals to microcomputer 502.” EX1044, Haigh-Hutchinson, ¶0081, FIG. 5. Likewise, buttons and other user input mechanism have long been known physical implements for effecting software procedures in computer systems. Procedures for user switching (*e.g.*, via input buttons) and/or handheld motion events in user-interface software were well-known as part of graphical user interface programming and understood since 2003. EX1014, Myers, 48-11, 48-20, 48-22.

4. Accelerometers, Gyros, and Magnetometers Were Well Known Motion Sensors.

63. Planar tri-axial accelerometers on a single chip were well-known in the art since 1982. EX1032, 3:60-4:14; *see also* EX1032, 2:11-3:31, FIG. 1. Further, MEMS accelerometers with submicron features and motion sensing in 3D were well-known in the art since 1996. EX1033, Abstract, 1:30-46, 12:35-47, Figs. 5, 6. In addition, MEMS gyroscopes for rotation sensing were fabricated and well-known in the art since 1991. EX1037, 0002, Fig. 2. Additionally, the '221 patent explicitly defines a motion sensor as “[a] sensor detecting motion” and states, “MEMS accelerometers, gyros, and magnetometers are *examples of motion[] sensors.*” EX1001, 10:62-11:3 (emphasis added).

64. The generic genus of motion sensors first started being developed in the 1960s for applications in view control (*e.g.*, head-mounted displays), navigation (*e.g.*, ships, submarines, airplanes), object selection or manipulation (*e.g.*, handheld devices), instrument tracking (*e.g.*, surgical tools), and avatar animation. EX1036, 24-28. For example, since the 1960s, inertial navigation systems were widespread, but utilized large and heavy “high-accuracy spinning-wheel gyroscopes,” not suitable for computer graphics input devices. *Id.*, 26. Not until the advent of MEMS inertial sensors (*e.g.*, accelerometers, gyros, etc.) in the 1980s did the integration of inertial input devices for computer graphics input devices begin such that position

and/or orientation of a device would be accurately measured with a few or a single, small integrated chip. *Id.*

65. The species of MEMS inertial sensors (*e.g.*, accelerometers, gyros, and magnetometers) first started being developed in the 1980s due to their small size, compact self-contained design, accuracy, and cost effectiveness. *Id.*, 24-28; *see also* EX1032; EX1033; EX1037. Small chip based accelerometers and gyros were used for dynamic motion (position, orientation, velocity and/or acceleration) sensing and control in a variety of medical and interactive graphics applications since 2002. *See* EX1036. For example, motion sensors were used for “augmented reality to assist with breast biopsy procedures,” to assist during “hip-replacement surgeries,” and to provide “head-and-hand tracking for projection-based interactive visualization.” EX1036, 32-36, Figs. 7, 11-13.

66. The species of claimed motion sensors, *e.g.*, “an accelerometer, gyro, or magnetometer,” adds nothing to patentability beyond the generic genus of well-known motion sensors, and “an accelerometer, gyro, or magnetometer” is merely a species of the generic genus of motion sensors. Moreover, both large scale motion sensors (*e.g.*, navigation gyroscopes) and small scale MEMS motion sensors (*e.g.*, accelerometers, gyros, magnetometers) were both well-known devices in the field for around 30 years before the earliest possible priority date of the '221 patent. Indeed, MEMS accelerometers and gyros were developed as early as the 1980s, and

a compact accelerometer chip and/or gyro chip would be and has been implemented in a variety of handheld devices for detecting position and/or orientation data of the handheld device. *See, e.g.*, EX1032; EX1033; EX1037.

V. THE '221 PATENT

A. Overview

67. Claim 1 is representative of the independent claims of the '221 patent and directed to a system including a handheld device for scanning a 3D environment and remotely controlling a view of a 3D environment on a display using a 3D sensor of a scanner. EX1001, 15:66-16:18. Claim 1 requires “at least one motion sensor is a sensor that directly detects motion.” *Id.*, 16:18. In contrast, independent claim 33 has a narrower requirement that “the at least one motion sensor is an accelerometer, gyro, or magnetometer” *Id.*, 18:17-18. The specification does not explicitly describe what it means for a motion sensor to *directly* detect motion, but does define what a “motion sensor” is and uses that terminology throughout the '221 patent's specification. In the '221 patent it states that a motion sensor is a sensor that uses “sound (acoustic sensors), opacity (optical and infrared sensors and video image processors), geomagnetism (magnetic sensors, magnetometers), reflection of transmitted energy (infrared laser radar, ultrasonic sensors, and microwave radar sensors), electromagnetic induction (inductive-loop detectors), and vibration (triboelectric, seismic and inertia-switch sensors). MEMS accelerometers, gyros,

and inertia-switch sensors). MEMS accelerometers, gyros and magnetometers are examples of motions sensors.” *Id.*, 10:62-11:3. As I discuss in my analysis of the below grounds, a POSA would consider each of an “accelerometer, gyro, or magnetometer,” among other devices such as those that use electromagnetic induction, to be a motion sensor that directly detects motion. *See id.*, 10:62-11:3.

68. The '221 patent states that scanning device can be used as remote controls for a display to adjust (*e.g.*, rotate, pan, and/or zoom) a displayed object. *Id.*, 4:12-23, 4:34-40. Additionally, the '221 patent states that the scanning device's ability to function as a remote control can be enabled by known motion sensors, such as accelerometers, in the scanning device. *Id.*, 4:41-50. The '221 patent further alleges that prior art systems required operators to utilize control devices (*e.g.*, a touch screen, a trackball, or a mouse) separate from the scanning device to adjust the scanned visual representation presented on the computer display. *Id.*, 4:51-55. The '221 patent alleges that the prior art control devices were inconvenient, awkward, difficult to use, labor-intensive, and costly to sterilize or disinfect. *Id.*

69. The '221 patent alleges, for some applications, prior art systems may require an operator to move away from a patient and put down the scanning device to remotely control a visual representation of a scanned 3D environment. In such cases, the '221 patent alleges that, using the disclosed scanning device, an operator can continuously work without having to release the handheld device when

switching between scanning a subject and adjusting a view of previously scanned images. *Id.*, 5:1-16, 5:23-26.

1. The '221 Patent Does Not Specify Any Novelty or Criticality of the Claimed Motion Sensors or Their Use.

70. The claims of the '221 patent recite a conventional use of a motion sensor. EX1001, 15:65-19:3. The '221 patent explains that, “[e]xamples of motion sensors are accelerometers, gyros, and magnetometers and/or the like.” EX1001, 6:66-7:1. Further, the '221 patent defines a motion sensor as “[a] sensor detecting motion” and states that “MEMS accelerometers, gyros, and magnetometers are *examples of motion[] sensors.*” *Id.*, 10:62-11:3 (emphasis added).

71. The '221 patent further lists a number of known motion sensors conventionally used in scanning devices without specifying any advantage, novelty, or criticality:

Motion sensor: A sensor detecting motion. Motion can be detected by: ***sound*** (acoustic sensors), ***opacity*** (optical and infrared sensors and video image processors), ***geomagnetism*** (magnetic sensors, ***magnetometers***), ***reflection of transmitted energy*** (infrared laser radar, ultrasonic sensors, and microwave radar sensors), ***electromagnetic induction*** (inductive-loop detectors), and ***vibration*** (triboelectric, seismic, and inertia-switch sensors). MEMS ***accelerometers, gyros, and magnetometers*** are examples of motion[] sensors.”

Id., 10:62-11:3 (emphasis added).

72. Thus, the '221 patent fails to specify any novelty or criticality of the claimed, “at least one motion sensor is an accelerometer, gyro, or magnetometer,”

and merely states “integration of the user interface functionality in the device 100 is provided by motion sensors...whose readings *determine the orientation*.” *Id.*, 11:66-12:4 (emphasis added).

B. Summary of Prosecution History

73. I have been informed that the '221 patent is a reissue of the cancelled '675 patent. The Examiner states that the reissue patent¹ was allowed because the prior art references Kopelman, Dillon, and Cinader, Jr., supposedly did not teach or render obvious the following limitation:

a handheld device including an optical scanner, wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment; and at least one display remotely connected to the handheld device, wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment, and the at least one display is adopted for visually representing the physical 3D environment; and the handheld device includes a user interface for remotely controlling the display to adjust the view with which the 3D environment is represented on the display.

EX1002, Prosecution History, 0013; *see also* EX1028, Kopelman; EX1029, Dillon; EX1030, Cinader, Jr.

74. The Examiner appears to allow the '221 patent based on subject matter of invalidated and canceled claim 1 of the '675 patent. EX1001, 17:66-18:18; EX1032, '675 patent. Indeed, a close reading of the Examiner's reasons for

¹ The '221 Patent is a narrowing reissue of U.S. Patent No. 9,329,675 (“the '675 patent”).

allowance indicates that he only addresses features found in invalidated and cancelled claims 1-19, and fails to address the “wherein the handheld device comprises at least one motion sensor” limitation (claim 1); the “the handheld device includes a 3D user interface for remotely controlling the display to adjust the view with which the 3D environment is represented on the display” limitation (claim 1); the “wherein the at least one motion sensor is a sensor that directly detects motion” limitation (claims 1, 19); the “at least one motion sensor for remotely controlling the display to adjust the view with which the 3D environment is represented on the display” limitation (claim 33); and the “wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer” limitations (claim 33).

75. I have been informed that claims 1-19 of the '675 patent were invalidated during IPR2018-00197 and then canceled in an *inter partes* review certificate issued on October 25, 2019, in accordance with U.S. Patent No. 9,329,675 K1. EX1033, IPR2018-00197 IPR Certificate. I have been further informed that, although the certificate issued prior to the Notice of Allowance issued May 11, 2020, and during prosecution of the '221 patent, neither the Patent Owner, nor the Examiner indicated they had submitted or reviewed the certificate. EX1002, 0007-0016; EX1032; EX1033; EX1034, IPR2018-00197 Final Written Decision. I have reviewed the final written decision (“FWD”) issued in IPR2018-00197 and the cancellation certificate.

76. As I will explain in detail below, the above limitations of a handheld scanning device: “wherein the handheld device comprises at least one motion sensor”; “the handheld device includes a 3D user interface for remotely controlling the display to adjust the view with which the 3D environment is represented on the display”; “wherein the at least one motion sensor is a sensor that directly detects motion”; “at least one motion sensor for remotely controlling the display to adjust the view with which the 3D environment is represented on the display”; and “wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer” were widely known in the field well before the earliest possible priority date of the ’221 patent.

1. FWD For The ’675 Patent Invalidated Claims 1-19, Including Claims Directed to “At Least One Motion Sensor.”

77. I have reviewed the FWD issued in IPR2018-00197 and the cancellation certificate, canceling claims 1-19 of the ’675 patent. I have been informed that the Board instituted that proceeding based on U.S. Patent Publication No. 2006/0020204 to Serra (EX1107) and U.S. Patent Publication No. 2007/0171220 to Kriveshko (EX1106), which I discuss and rely upon in this Declaration, to invalidate claims 1-19 of the ’675 patent. Claims 4-8 and 19 of the ’675 patent included “at least one motion sensor.” EX1034, 10, 63.

78. Regarding claims 4, 5, 8, and 19 of the '675 patent, I have been informed that the Board determined that Serra teaches their limitations, and rejected Patent Owner's arguments regarding the recited "motion sensor." I understand that the Board stated that a 3D sensor is a motion sensor because it determines motion by tracking "position and orientation." *Id.*, 54. I further understand that the Board cited expert testimony explaining that, "a POSITA would have understood that Serra's 3D sensor at least suggests a motion sensor given that Serra's 3D sensor is used to *determine the three-dimensional movement of the scanning device.*" *Id.*

79. In my opinion, because the Board was "persuaded [in IPR2018- 00197] that Petitioner has shown by a preponderance of the evidence that claims 4, 5, 8, and 19 would have been obvious over the Kriveshko and Serra combination," (*id.*, 59), claims 1-3, 5-7, 9-11, 15, 18-28, 30-34, and 40-44 of the '221 Patent (reissue of the '675 Patent) are also unpatentable and obvious over Serra and Kriveshko for at least the same reasons as claims 4, 5, 8, and 19 of the '675 patent.

2. Claims of the '221 Patent Are Based on Invalidated Claims 1-19 of the '675 Patent and Should Not Have Been Allowed.

80. As discussed above, I have been informed that the Patent Owner has only added claim limitations in reissue directed to species of motion sensors (accelerometers, gyros, or magnetometers) to the generic motion sensors that were subject of the invalidated claims of the '675 patent. Further, as discussed, claims 1-

19 were invalidated, including claims 4, 5, 8, and 19 specifically directed to a motion sensor. But, in my opinion, the addition of a specific kind of motion sensor to the claims—an accelerometer, gyro, or magnetometer—does not add novelty to the claims. The specification does not describe that the type of motion sensor used is critical for any reason. Thus, in my opinion, claims 1-3, 5-7, 9-11, 15, 18-28, 30-34, and 40-44 of the '221 patent are not patentable and should not have been allowed because the claimed generic genus of motion sensors was previously invalidated in the FWD of IPR2018-00197 (*e.g.*, claims 1-19 of the '675 patent).

81. I have been further informed that, in allowing the '221 patent, the Examiner failed to address whether the claimed species (“an accelerometer, gyro, or magnetometer”) of the generic genus of motion sensors was patentably distinct from invalidated and cancelled claims 1-19. EX1002, 0013; *see also* EX1029; EX1030; EX1031. Therefore, in my opinion, for these additional reasons, claims 1-3, 5-7, 9-11, 15, 18-28, 30-34, and 40-44 of the '221 patent are unpatentable and should not have been allowed.

VI. CLAIM CONSTRUCTION

82. I have been informed and understand that claims are given their plain and ordinary meaning as would be understood by a POSA in view of the patent as a whole. A Patent Owner can define a term of a claim when they act as a lexicographer and clearly set forth a definition of the claim term or if they disclaim or disavow

claim scope during prosecution. Thus, where a clear definition has been provided, the claim term will receive the definition set forth in the '221 patent specification.

VII. OVERVIEW OF GROUNDS ASSERTED IN THE PETITION AND PRIOR ART

83. I understand that Petitioner is challenging the following claims of the '221 patent under the following Grounds:

Ground	References	Basis	Challenged Claims
1	Gattani ²	§§ 102, 103	1, 5, 9, 18, 22-26, 28, 31, and 33
2	Kriveshko ³ , Serra ⁴ , Hopkins ⁵	§ 103	1-3, 5-7, 9-11, 15, 18-21, 23-28, 30-34, and 40-44
3	Kriveshko, Serra, Hopkins, Wilson ⁶	§ 103	22
4	Kriveshko, Serra, Hopkins, Quaid ⁷	§ 103	30
5	Kriveshko, Serra, Marvit ⁸	§ 103	1-3, 5-7, 9-11, 15, 19-28, 30-34, and 40-44
6	Kriveshko, Serra, Marvit, Quaid	§ 103	30

² U.S. Patent Publication No. 2008/0071143 (“Gattani”), published on March 20, 2008.

³ U.S. Patent Publication No. 2007/0171220 (“Kriveshko”), published on July 26, 2007.

⁴ U.S. Patent Publication No. 2006/0020204 (“Serra”), published on January 26, 2006.

⁵ U.S. Patent No. 8,914,245 (“Hopkins”), filed as provisional application No. 61/161,910 on March 20, 2009.

⁶ U.S. Patent Publication No. 2005/0110751 (“Wilson”), May 26, 2005.

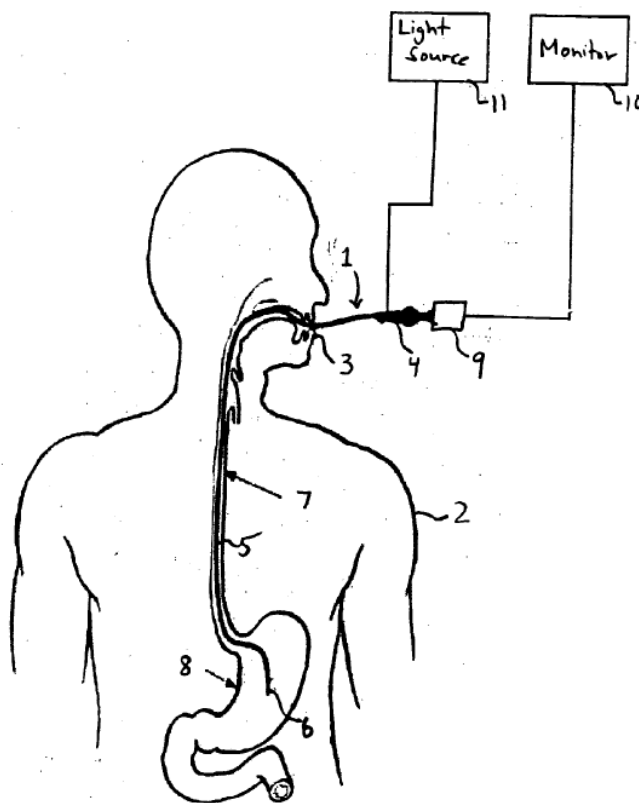
⁷ U.S. Patent Publication No. 2006/0142657 (“Quaid”), June 29, 2006.

⁸ U.S. Patent Publication No. 2005/0212756 (“Marvit”), published on September 29, 2005.

A. Overview of Gattani

84. Gattani is U.S. Patent Publication No. 2008/0071143 and lists a publication date of March 20, 2008. Based on the earliest possible priority date of the '221 patent, I understand that this makes Gattani prior art under § 102(b).

85. Gattani is titled “Multi-dimensional Navigation of Endoscope Video.” EX1105, Title. Gattani is broadly directed to, “[a]n endoscopic surgical navigation system [that] comprises a multi-dimensional video generation module that enables a user to visually navigate captured endoscopic video with six degrees of freedom. This capability provides the user with control of a virtual camera (point of view) that can be translated in three orthogonal axes in 3-D space as well as allowing control of vertical panning (pitch), horizontal panning (yaw) and tilt (roll) of the virtual camera, as well as zoom.” *Id.*, Abstract.



Id., Fig. 1.

86. Gattani explains that, “[b]ecause endoscopes have limited field of view, localization of target lesions and navigation to the desired areas through small entry points can be difficult. Furthermore, some parts of the body contain extremely small and/or complex structures that are difficult for a surgeon to see through an endoscope or in endoscopic video.” *Id.*, ¶0005. To address this problem, Gattani explains, “[a] visual navigation system for use in endoscopic surgery, particularly (though not exclusively) in endoluminal surgery, is described.” *Id.*, ¶0036. Gattani further explains that, “[i]n view of the challenges mentioned above, it is desirable to provide a visual navigation system to provide coupled three-dimensional (3D) visualization

and navigation assistance to the surgeon in navigating an endoscope to the target anatomy, particularly during endoluminal surgery.” *Id.*, ¶0037.

87. Gattani further discloses a system that uses position sensors (such as electromagnetic sensors or optical sensors) on the distal tip of an endoscope inserted inside a patient to capture position. *Id.*, ¶¶0047, 0058, 0064, 0073, 0088, 0094, 0099-111. Similarly, the position and orientation of the base of the endoscope may also be tracked. *Id.*, ¶¶0105-0111.

88. The system of Gattani uses the position/orientation information to determine the view on a display: “Initially, the VNS 30 concurrently inputs intra-operative scan data, position/orientation data from the sensors on the scope, and live video from the endoscopic video camera, at 501a, 501b and 501c, respectively. At 502 the VNS 30 determines the current position and orientation of the scope’s distal tip. At 503 the VNS 30 generates real-time 3-D (volumetric) scan images, based on the intra-operative scan data and the current position and orientation of the scope’s distal tip. The VNS 30 then coregisters the real-time 3-D scan images with the live video from the endoscopic video camera at 504. The coregistered scan images and live video are then sent to a monitor (which may be integral with or external to the VNS 30) for display, to an image recording device for recording, and/or to a network interface for transmission over a network.” *Id.*, ¶0064.

89. Gattani explains, “[t]he VNS can automatically detect movement of the flexible endoscope during an endoscopic procedure and, in response, identify a particular slice of scan data corresponding to a current location and orientation of the endoscope tip and cause an image of the slice to be displayed, and similarly cause other slices of scan data to be displayed in response to additional movements of the endoscope.” *Id.*, ¶0048. The “VNS” as describe in Gattani is short for “Visual Navigation System.” The user is also able to navigate the video with six degrees of freedom. *Id.*, ¶0052.

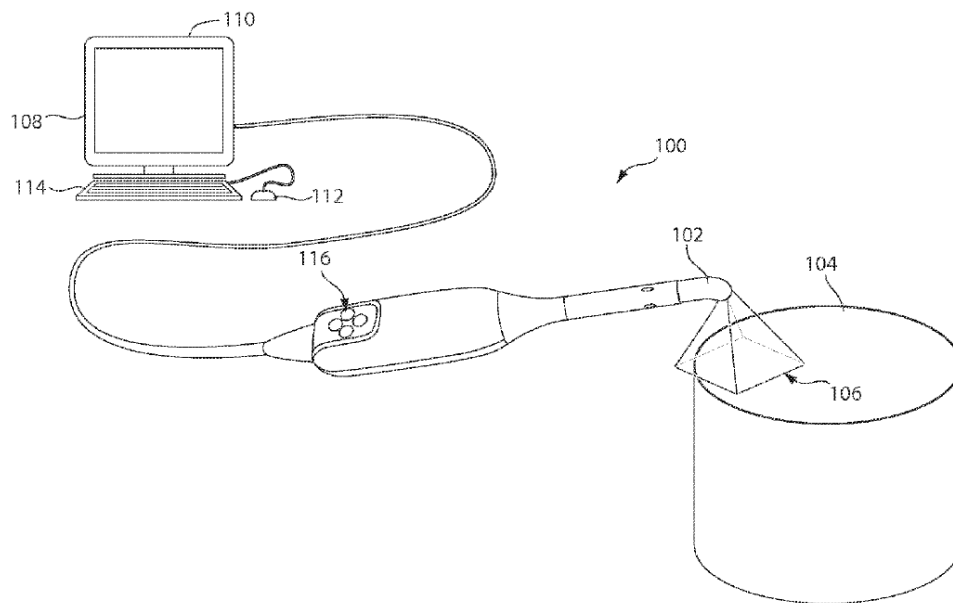
90. Gattani further explains that multiple views can be displayed simultaneously and coregistered. *Id.*, ¶0088. Gattani explains that he is improving on prior methods that allow a user to traverse a video in only the time dimension by also allowing the user to traverse the position and orientation information. *Id.*, ¶¶0113, 119.

B. Overview of Kriveshko

91. Kriveshko is U.S. Patent Publication No. 2007/0171220 and lists a publication date of July 26, 2007. Based on the earliest possible priority date of the ’221 patent, I understand that this makes Kriveshko prior art under § 102(b).

92. Kriveshko is titled, “Three-dimensional scan recovery.” EX1106, Title. Kriveshko discloses a system for, “scan[ning] complex surfaces...by maintaining a continuous three-dimensional scan across separated subsections of the surface.”

EX1106, ¶0008-0010. Kriveshko explains that the system includes an intraoral scanner that captures images of a subject (*e.g.*, a tooth, a quadrant of teeth, or a full collection of teeth) within an image plane, and forwards the images to a computer that includes a display. *Id.*, ¶¶0049, 0051, 0052, 0054. The scanner 102 acquires 2D image sets while passed over a surface of the subject. *Id.*, ¶0058, 0063. Further, the 2D image sets can be forwarded to the computer for derivation of 3D point clouds. *Id.*



Id., Fig. 1.

93. Kriveshko presents 3D point clouds (*i.e.*, a 3D model) within a user interface rendered a display. *Id.*, ¶0076. The user interface allows user manipulation the 3D model via various controls. *Id.*, ¶¶0090-0091. For example, the user controls provide functionality for rotating, scaling, and panning the 3D model. *Id.* Kriveshko

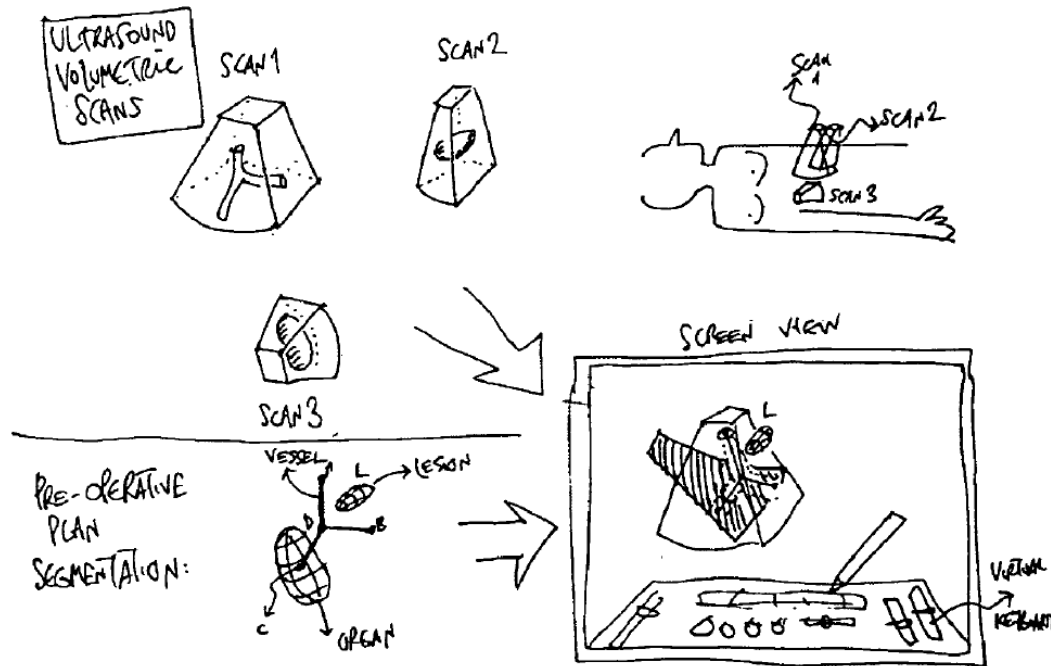
further discloses that the user controls for manipulating the 3D model are selected via a user interface input element on the scanning device. *Id.* Kriveshko explains, “[t]he scanner 102 is a handheld, freely positionable probe having at least one user input device, such as a button, lever, dial, thumb wheel, switch, or the like, for user control of the image capture system 100 such as starting and stopping scans.” EX1106, ¶¶ 0052, 0100, 0101.

C. Overview of Serra

94. Serra is U.S. Patent Publication No. 2006/0020204 and lists a publication date of January 26, 2006. Based on the earliest possible priority date of the '221 patent, I understand that this makes Serra prior art under § 102(b).

95. Serra discloses a system for acquiring 3D data via a scanning device in a scanning mode, and presenting the 3D data on a display. EX1107, Serra, ¶0012. Generally, Serra discloses, “[a] system and method for the imaging management of a 3D space where various substantially real-time scan images have been acquired is presented. In exemplary embodiments according to the present invention, a user can visualize images of a portion of a body or object obtained from a substantially real-time scanner not just as 2D images, but as positionally and orientationally located slices within a particular 3D space.” *Id.*, Abstract. In particular, Serra discloses that the system “allows a user to manage the different images obtained...and to

manipulate them as well as control various display parameters, for example, their visualization.” *Id.*, ¶0035.



Id., Fig. 5.

96. Serra further discloses a handheld scanning device that can control display parameters to interactively manipulate 3D data in an interactive visualization mode. *Id.*, ¶¶0053-0054. To that end, Serra further discloses “one or more switches, or other manual actuators, can be provided on or for a handheld probe to enhance 3D interactions,” and a user can “control display parameters by actuating one or more buttons on the probe...to rotate the entire virtual scene.” *Id.*, ¶0053. In addition, Serra discloses that the buttons of the scanning device may be used to switch between a scanning mode and an interactive visualization mode. *Id.*, ¶¶0053-0054.

97. Serra discloses that the “probes and instruments can, for example, be tracked by a 3D tracking system so that the each of the probes’ and instruments’ respective 3D positions and orientations can be known at all times.” *Id.*, ¶0042. Serra explains that the scanning device includes a 3D sensor for real-time position and orientation data of the scanning device. *Id.*, ¶¶0036, 0042, 0049, Figs. 7, 8, 10. The 3D sensor collects and records 3D position, 3D orientation, and time values corresponding to the movement of the scanning device. *Id.* For example, Serra discloses that, “a user can visualize images of a portion of a body or object obtained from a substantially real-time scanner not just as 2D images, but as positionally and orientationally identified slices within the relevant 3D space. In exemplary embodiments of the present invention, a user can convert such slices into volumes as desired, and can process the images or volumes using known image processing and/or volume rendering techniques. Alternatively, a user can acquire ultrasound images in 3D using the techniques of UltraSonar or 4D Ultrasound. In exemplary embodiments of the present invention, a user can manage various substantially real-time images that have been obtained, either as slices or volumes, and can control their visualization, processing and display, as well as their registration and fusion with other images, volumes or virtual objects obtained or derived from prior scans of the area or object of interest using various modalities.” *Id.*, Abstract.

98. In some embodiments, Serra discloses “the 3D position of the ultrasound probe 715 can be tracked by 3D tracker 703, by, for example, 3D sensor 720 which is attached to ultrasound probe 715.” *Id.*, ¶¶0074, Figs. 7, 8, 10. In addition, Serra discloses a user can use the “tracked handheld tool to control the way in which to see the objects by performing various 3D volumetric operations upon them, such as, for example...Zoom Slider, Zoom Context and 3D Matching.” *Id.*, ¶0057. Serra also discloses that views may be rotated. *Id.*, ¶¶0053, 0054, 0058.

99. Further, Serra discloses that a user can interactively manipulate a visual representation of scanned 3D data presented on a display based on position and orientation data from the 3D sensor. *Id.*, ¶¶0036, 0042, 0049, 0053-0054, Figs. 7, 8, 10.

D. Overview of Hopkins

100. Hopkins is U.S. Patent No. 8,914,245 and was filed as provisional application number 61/161,910 on March 20, 2009. Based on the earliest possible priority data of the '221 patent, I understand that this makes Hopkins prior art under § 102(e).

101. Hopkins is titled “Ultrasound Probe with Accelerometer.” EX1108 at Title. Hopkins explains, “[t]he accelerometer (32) is configured to detect the movement of the probe (10) in from two to three axes when the probe (10) is rotated or moved in a linear direction to allow the probe (10) to detect images from more

than one plane.” *Id.* at Abstract. Hopkins further describes that “[t]he accelerometers used with the probe of this invention can be a low cost analog device.” *Id.* at 1:49-50.

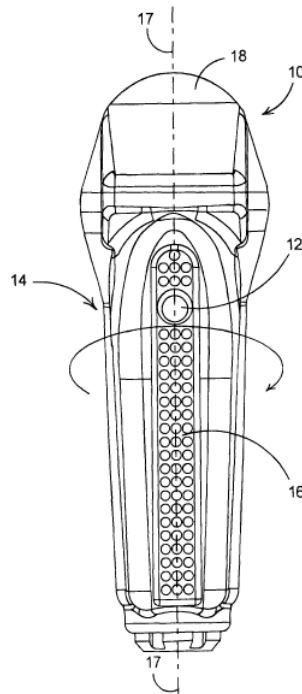


FIGURE 1

Id., Fig. 1.

102. Hopkins explains, “[u]nder the influence of external accelerometers that are transmitted via the casing the MEMS sensor deflects from its neutral position. This deflection is measured in an analog or digital manner. Most commonly the capacitance between a set of fixed beams and a set of beams attached to the proof mass is measured. This method is simple, reliable and does not require additional process steps making it inexpensive.” *Id.* at 3:5-12. Hopkins further explains, “[a]n accelerometer measures the non-gravitational acceleration it experiences. It is

simplest to consider that the gravitational forces accelerate the whole accelerometer equally, and therefore give no reading. Non-gravitational acceleration is produced by forces other than gravity or inertial forces. Such forces include all simple mechanical forces. These are transmitted to the accelerometer device through mechanical stress on its mounting.” *Id.* at 3:13-20.

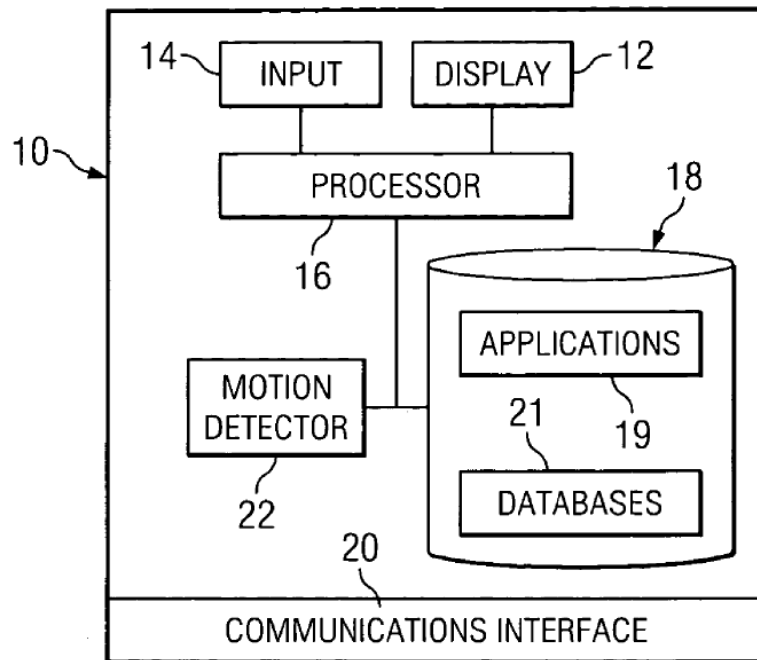
103. Hopkins explains that the use of a 3D accelerometer on the ultrasound probe allows for new and improved image capture techniques to be implemented. *Id.* at 3:56-63, 4:53-57; 4:66-5:5; 5:50-6:39. For example, Hopkins explains that an “abdominal probe scan of the bladder the prostate is usually scanned in the anteroposterior and sagittal planes and as described before for the abdominal probe, the 90° turn can be automatically detected using the MEMS32 accelerometer sensor and the image automatically saved.” *Id.* at 6:18-23.

E. Overview of Marvit

104. Marvit is U.S. Patent Publication No. 2005/0212756 and lists a publication date of September 29, 2005. Based on the earliest possible priority date of the '221 patent, I understand that this makes Marvit prior art under § 102(b).

105. Marvit discloses a handheld device that uses accelerometers to measure movement for the purpose of device control and gesture recognition. EX1109, Marvit, Abstract, ¶¶0042, 0043. Marvit explains that his inventive “handheld device” is application agnostic. *Id.*, ¶0034. Marvit discloses that the handheld device

can include a display, an input, and a motion detector to provide “an interface for a user to communicate input to the device.” *Id.* Marvit teaches that the motion detector can track movement of the handheld device and that movement can “be used as a form of input to perform certain functions.” *Id.*, ¶¶0038-0040. For example, “input movement may be in the form of translation and/or gestures” of the handheld device and “translation-based input...may change the display during the movement.” *Id.*, ¶0040.



Id., Fig. 1.

106. Marvit discloses that input 14 of handheld device 10 “provides an interface for a user to communicate input to the device. Input 14 may comprise a keyboard, keypad, track wheel, knob, touchpad, stencil or any other component

through which a user may communicate an input to device 10.” *Id.*, ¶0035. Marvit also discloses that motion detector 22 can include accelerometers and gyros that detect movement of the handheld device. *Id.*, ¶¶0038-0044, 0051, 0052.

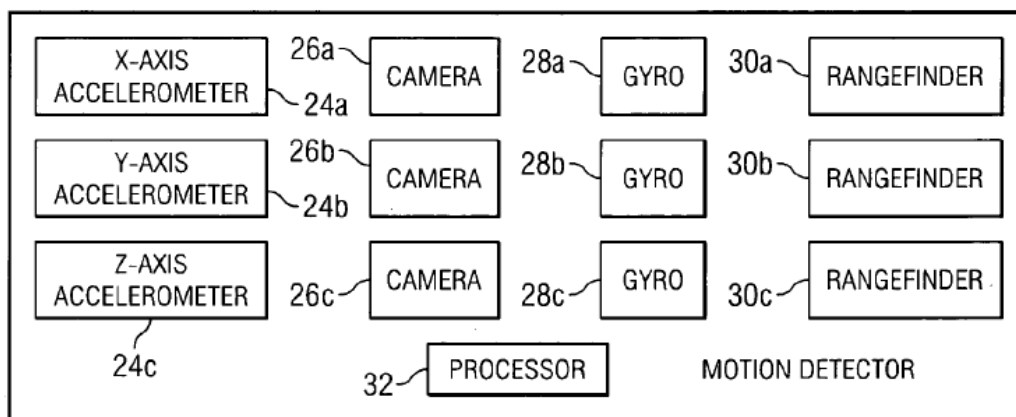
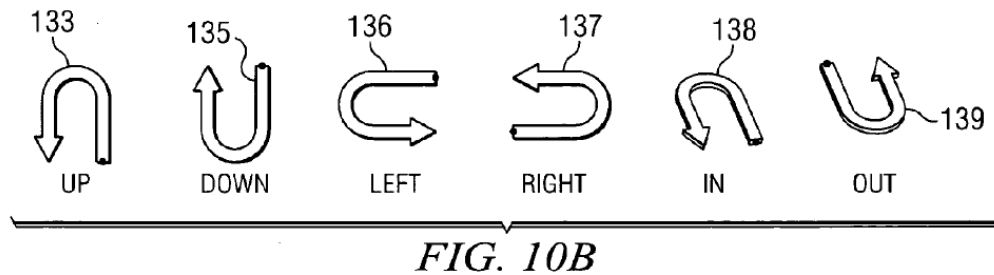
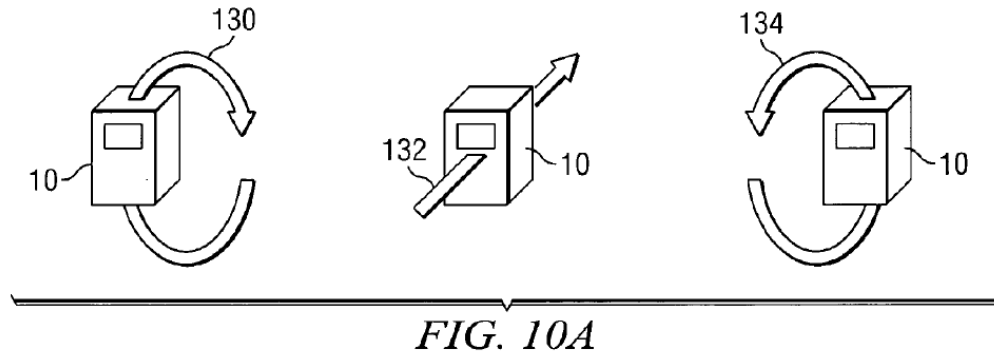


FIG. 2

Id., Fig. 2. In some embodiments, the motion detectors (*i.e.*, accelerometers) “are able to detect rotation and translation of device 10 . . . rotation and/or translation of device 10 may serve as an input from a user to operate the device.” *Id.*, ¶0044. For example, a user interface function can utilize input motion along one axis to “allow a user to scroll through a list displayed on the handheld device by moving the device along a particular axis.” *Id.*, ¶¶0056-0058.

107. Marvit discloses, “there may be value in having the position of a virtual display, or the information displayed at display 12 of handheld device 10, linked to the position of the device,” and further describes manipulating the display based on the position of the handheld device 10. *Id.*, ¶¶0063-0066. For example, Marvit discloses navigating across a virtual desktop by movement (*e.g.*, gestures) of the

handheld device for panning, zooming, and rotating a display. *Id.*, ¶¶0080-0086, 0165-0167. Marvit further discloses controlling a remote display (e.g., on glasses, contacts, a laptop, a remote device) by movement of the handheld device. *Id.*, ¶¶0122, 0125, 0167.



Id., Figs. 10A-B (illustrating gestures).

F. Overview of Wilson

108. Wilson discloses a hand-held device that uses multiple sensors and sensor fusion techniques to determine the orientation of the handheld device. EX1110, ¶¶0046 (handheld), 0076 (“sensor fusion”).

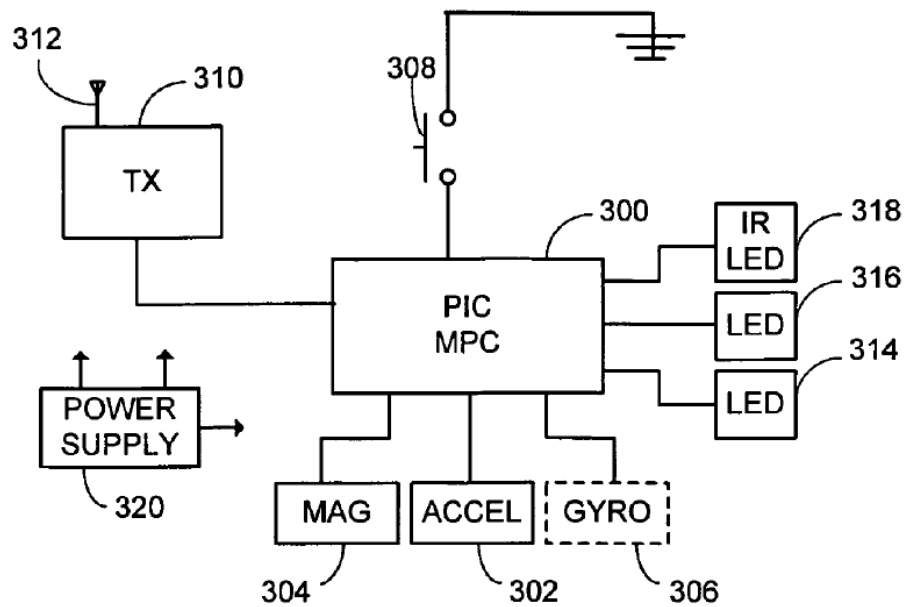


FIG. 3

Id., Fig. 3.

G. Overview of Quaid

109. Quaid discloses placing displays and other hardware on carts, and the benefits of having a medical device on a cart. EX1111, ¶¶0093 (display on cart), 0096 (benefits of carts in the medical context).

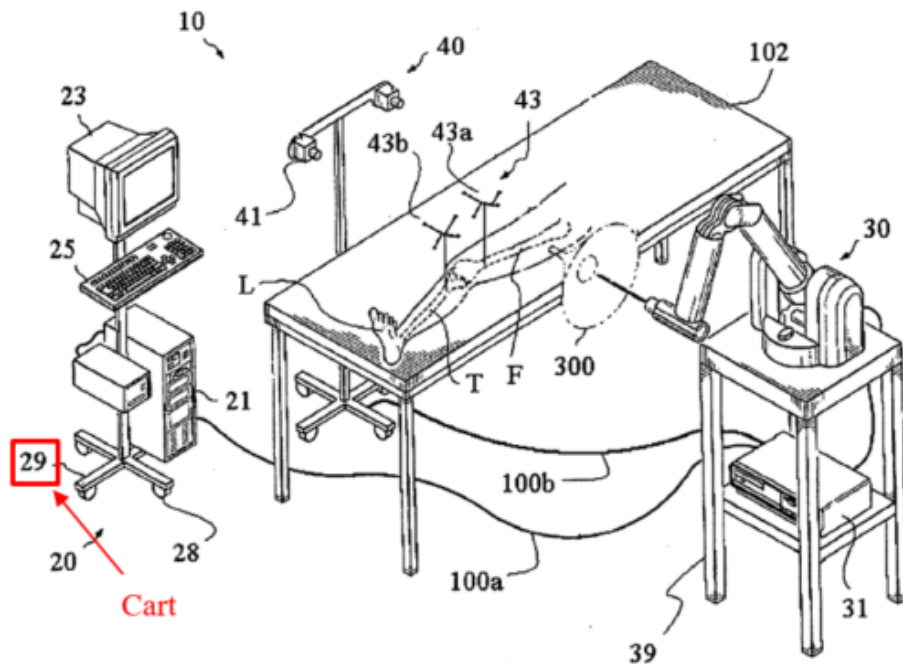


FIG. 1

Id., FIG. 1 (annotated).

VIII. GROUND 1: CLAIMS 1, 5, 9, 18, 22-26, 28, 31, AND 33 ARE ANTICIPATED BY GATTANI

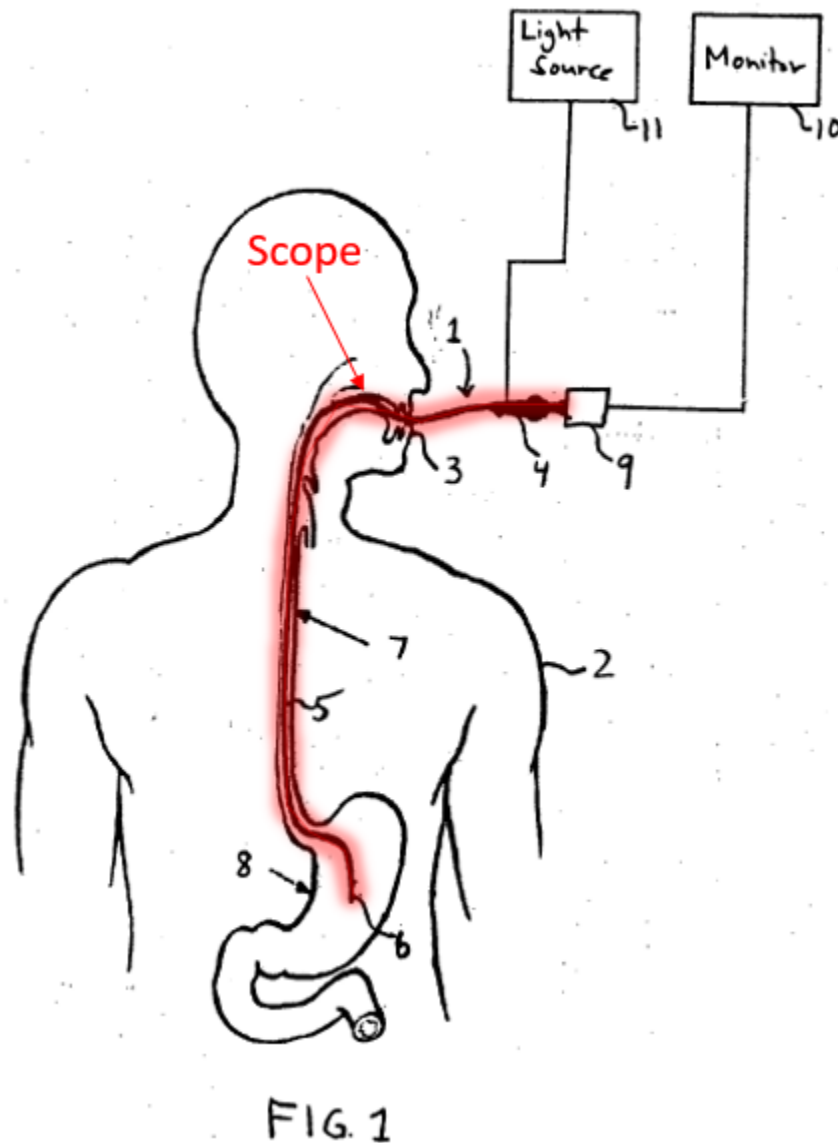
A. Claim 1

110. Gattani anticipates claim 1. Labels (*i.e.*, [1.0]) have been appended to the claim limitations for ease of reference.

1. [1.0] A scanning system for scanning a 3D environment, the scanning system comprising:

111. Gattani discloses a scanning system for scanning a 3D environment. The scanning system of Gattani is “an endoscopic surgical navigation system.” EX1105, Abstract. That endoscopic surgical navigation system includes a flexible endoscope (“scope”) 1 that is inserted into the body. EX1105, ¶0054. The body is a

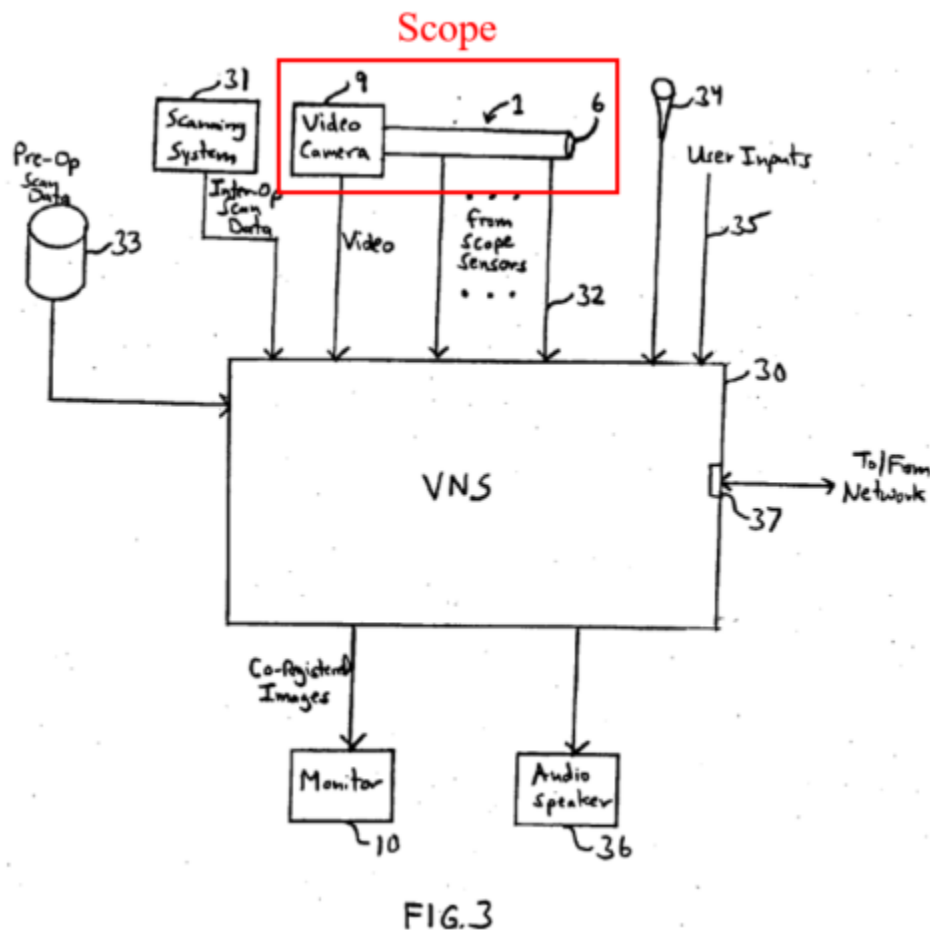
3D environment. The scope 1 is “optically coupled” to an “endoscopic video camera 9 which outputs a video signal to a display device (monitor) 10.” *Id.*



Id., Fig. 1.

112. The endoscopic surgical navigation system further includes a Visual Navigation System (VNS) 30 that receives “live video” of the body from the

endoscopic video camera 9. *Id.*, ¶¶0058, 0064. Figure 3 below illustrates data received by the VNS for the scope 1:



2. [1.1] a handheld device including an optical scanner

113. Gattani discloses a handheld device including an optical scanner. Scope 1 is held by the surgeon when the surgeon is navigating the scope through the body: “The distal tip 6 of the scope 1 is part of the flexible portion 5 and can be flexed about two or more orthogonal axes by the surgeon, by using controls (not shown) mounted on the base 4. The surgeon navigates the scope 1 through a natural body

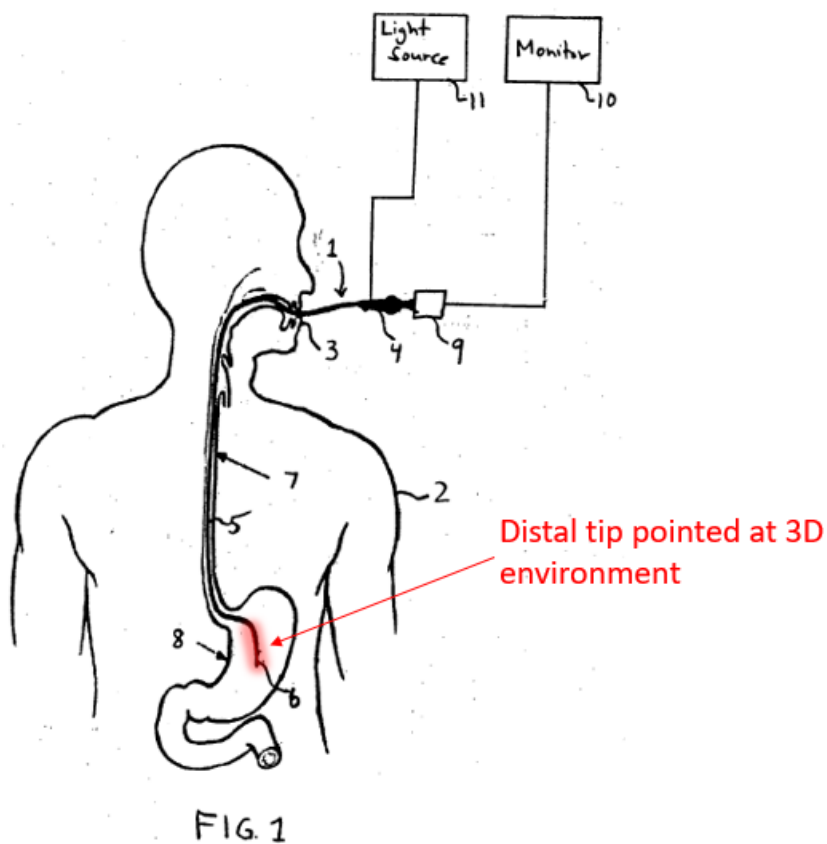
lumen, such as the esophagus 7 and stomach 8 until the distal tip 6 of the scope 1 is in proximity to the target anatomy.” *Id.*, ¶0054.

114. As discussed in [1.0] of this Ground, the scope 1 is a handheld device that includes an endoscope video camera 9. The endoscopic video camera 9 is an optical scanner since Gattani discloses that, “[o]ptically coupled to the base 4 of the scope 1 is an endoscopic video camera 9.” *Id.*, ¶0055. Gattani further discloses that, “the VNS 30 determines the current position and orientation of the scope’s distal tip. At 503 the VNS 30 generates real-time 3-D (volumetric) scan images, based on the intra-operative scan data and the current position and orientation of the scope’s distal tip. The VNS 30 then coregisters the real-time 3-D scan images with the live video from the endoscopic video camera at 504.” *Id.*, ¶0064. The endoscopic video camera 9 is optical scanner because it records/scans images (video).

3. [1.2] wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment; and at least one display remotely connected to the handheld device

115. Gattani discloses wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment and at least one display remotely connected to the handheld device. As discussed in [1.0] of this Ground, Gattani includes a scope 1 that has a distal tip 6 of a flexible portion 5 that is optically coupled to the an endoscope video camera 9, and light is transmitted to through the flexible portion to the an endoscope video camera 9 to obtain images from the

perspective of the distal tip. *Id.*, ¶¶0054-55. The flexible portion 5 is inserted into the body such that the distal tip 6 is in the proximity of the anatomy to be scanned (“target anatomy”). *Id.* (“The distal tip 6 of the scope 1 is part of the flexible portion 5 and can be flexed about two or more orthogonal axes by the surgeon, by using controls (not shown) mounted on the base 4. The surgeon navigates the scope 1 through a natural body lumen, such as the esophagus 7 and stomach 8 until the distal tip 6 of the scope 1 is in proximity to the target anatomy.”).



Id., Fig. 1 (annotated). The body is a 3D environment and the area to be scanned is selected by pointing the tip of the scope at a portion of the body.

116. Gattani further discloses at least one display remotely connected to the handheld device. Gattani discloses that the external monitor 10 of the VNS 30 can be connected to receive data from the endoscopic video camera 9 coupled to the scope 1 remotely over a network such as a local area network, a wide area network, or the internet. *Id.*, ¶0059. “The coregistered scan images and live video are then sent to a monitor (which may be integral with or external to the VNS 30) for display, to an image recording device for recording, and/or to a network interface for transmission over a network.” *Id.*, ¶0064. In such a configuration, the display 10 of the VNS 30 is remotely connected to the scope 1 because it is connected via a network and thus the scope 1 and the display 10 can be remotely positioned from one another anywhere within the range of the network. In the case of the internet, for example, the scope 1 and the external monitor 10 may be in Florida and the scope may be located in Minnesota. Alternatively, the display is remote from the display 10 because the scope 1 is separate from the display 10.

117. Further, I note that the '221 patent discloses that a display does not need to be on the handheld device. *Id.*, 6:5-6. And, the '221 patent further discloses that the scanner can also be remotely located outside of the direct user area. *See id.*, 4:63-67.

4. **[1.3] wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment**

118. Gattani discloses wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment. As discussed in [1.0] of this Ground, the endoscopic surgical navigation system further includes a Visual Navigation System (VNS) 30 that receives “live video” of the body from the endoscopic video camera 9. *Id.*, ¶¶0058, 0064. The body is a physical 3D environment. The scanning action is the recording of the live video. Gattani explains that, “during endoscopic surgery, the video that is acquired from the endoscopic video camera 9 is a sequence of images captured through the scope 1, while the scope 1 is pointed in different directions at different instants in time. The video can be recorded as it is acquired.” *Id.*, ¶0112.

5. [1.4] and the at least one display is adapted for visually representing the physical 3D environment

119. Gattani discloses the at least one display is adapted for visually representing the physical 3D environment. In Gattani, “a display device (monitor) 10, which may be, for example, a cathode ray tube (CRT) display, liquid crystal display (LCD), or other suitable type of display device[]” is used. *Id.*, ¶0064. The display 10 may visually represent the physical 3D environment inside a person’s body in the manner depicted in Fig. 2 below.

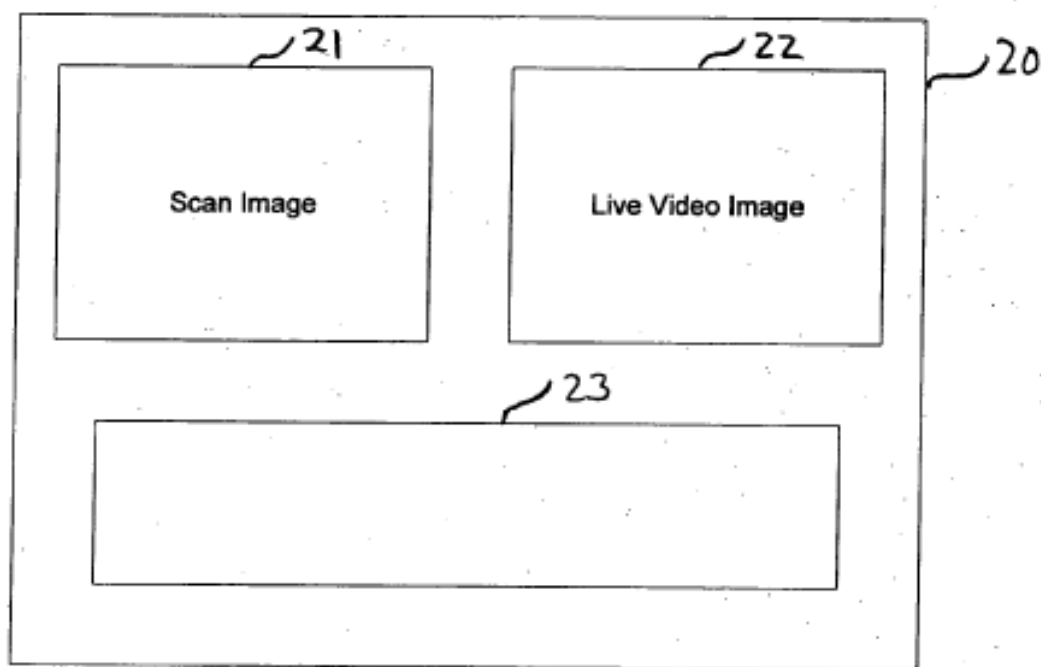


Fig. 2

120. Gattani explains that, “[a]s shown in FIG. 2, a display 20 generated by the VNS includes several windows in proximity to each other, including a window 21 that contains a scan image and a window 22 that contains a corresponding live video image, presented side-by-side.” *Id.*, ¶¶0057; *see also*, ¶¶0088-92 (describing other types scans and representations of the physical representation of inside a person’s body that can be displayed), 0096-97 (describing display based on position and orientation of the scope tip). Display 10/20 with windows 21 and/or 22 is a display adapted for visually representing the physical 3D environment.

6. [1.5] the handheld device includes a 3D user interface for remotely controlling the display to adjust the view with which the 3D environment is represented on the display

121. Gattani discloses the handheld device includes a 3D user interface for remotely controlling the display to adjust the view with which the 3D environment is represented on the display. In Gattani, “[t]he distal tip 6 of the scope 1 is part of the flexible portion 5 and can be flexed about two or more orthogonal axes by the surgeon, by using controls (not shown) mounted on the base 4.” *Id.*, ¶0054. Further, the VNS of Gattani includes a “user interface subsystem” 46, and the user interface subsystem “interprets and passes user commands received in the form of any one or more of: voice, gestures, touch screen inputs, button presses, etc.” *Id.*, ¶0061.

122. Gattani further discloses a 3D user interface, including by disclosing “three-dimensional (3D) visualization and navigation assistance to the surgeon in navigating an endoscope to the target anatomy.” *Id.*, ¶0037. Gattani explains:

In response to scope movements, the data processing subsystem 44 can also automatically identify a particular slice of intra-operative or pre-operative scan data corresponding to the current location and orientation of the endoscope tip and cause an image of that slice to be displayed to the user from the viewpoint of the scope tip.

Id., ¶0113. This is accomplished in Gattani by computing position and orientation of an image plane for each video frame as a function of the corresponding position and orientation of the distal tip of the endoscope and transforming the image planes for

the frames to user-specific spatial positions and orientations in response to user inputs. *Id.*, ¶¶0062, 0064, 0073, 0088, 0098, claims 1-4.

123. The VNS 30 receives inputs 32 from various sensors on the endoscope 1, which are used to determine the current position and orientation of the distal tip 6 of the scope 1. *Id.*, ¶¶0058. More particularly, Gattani uses sensors 104 on the scope 1 containing three small wire coils oriented perpendicular to each other. *Id.*, ¶¶0100. The electromagnetic field 103 generated by the generator induces current through these coils, which at any particular instant in time is dependent upon the electromagnetic field strength at the location of the sensor and the orientation of the sensor relative to the generator. *Id.* “Hence, the distance and orientation of the sensor 104 relative to the generator can be determined from those currents.” *Id.*

124. The position/orientation sensors 104 of Gattani that determine the location and orientation of the endoscope are a 3D user interface. *Id.*, ¶¶0099-100. Further, Gattani discloses that, “an endoscopic surgical navigation system comprises a multi-dimensional video generation module that enables a user to visually navigate captured endoscopic video with six degrees of freedom. This capability provides the user with control of a virtual camera (point of view) that can be translated in three orthogonal axes in 3-D space as well as allowing control of vertical panning (pitch), horizontal panning (yaw) and tilt (roll) of the virtual camera, as well as zoom.” *Id.*, Abstract.

7. [1.6] wherein the handheld device comprises at least one motion sensor

125. Gattani discloses wherein the handheld device comprises at least one motion sensor. The '221 patent defines a “motion sensor” as a “sensor detecting motion” and identifies electromagnetic induction (inductive-loop detectors), among other sensors, as an exemplary motion sensor. EX1001, 10:62-11:3. Gattani discloses motion sensing via electromagnetic induction. In particular, the scanning system of Gattani comprises scope tracking using “signals from position/ orientation sensors on the scope to track the current position and orientation of the distal tip of the scope.” EX1105, ¶0099-100, 0104-11. Sensors 104 are depicted in Figure 10 (annotated) below.

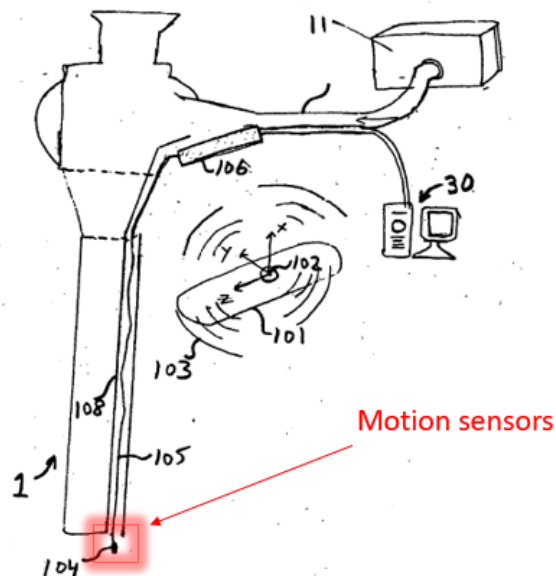


FIG. 10

126. Gattani further explains that an electromagnetic field generator is placed under a patient table 10, and, as discussed in connection with Gattani's 3D user interface, the position and orientation of the scope 1 is tracked using sensors 104 containing three perpendicularly oriented coils each of which receives a magnetic field induced from the field generator and by calculating the strength and vector direction of the field via these sensors, one is able to determine position and orientation. *Id.*, ¶0100. Thus, the handheld device in Gattani comprises at least one motion sensor.

8. [1.7] wherein the at least one motion sensor is a sensor that directly detects motion

127. Gattani discloses wherein the at least one motion sensor is a sensor that directly detects motion. The '221 patent identifies electromagnetic induction (inductive-loop detectors) as an exemplary motion sensor that directly detects motion. EX1001, 10:62-11:3. The electromagnetic sensors 104 of Gattani directly detect motion. Using the electromagnetic sensors 104 of Gattani, a POSA would understand that position and orientation measurements would be acquired by these sensors at discrete and consecutive sample times, any change or absence of change between two consecutive samples is a direct indication of motion between the consecutive samples. Therefore, consistent with the '221 patent, motion is directly detected by the electromagnetic sensors 104 of Gattani.

128. Gattani further explains that the detected motion of the scope 1 can be used to create a travel path for the scope which can be visually displayed to a user in 3D: “The path correlation module 79 receives data indicating the current position and orientation of the scope from the tracking subsystem 42. It converts the data into a dataset representing the path taken by the scope, and transforms that dataset into graphic model parameters to enable the path to be rendered and displayed to a user in 3D.” *Id.*, ¶0134.

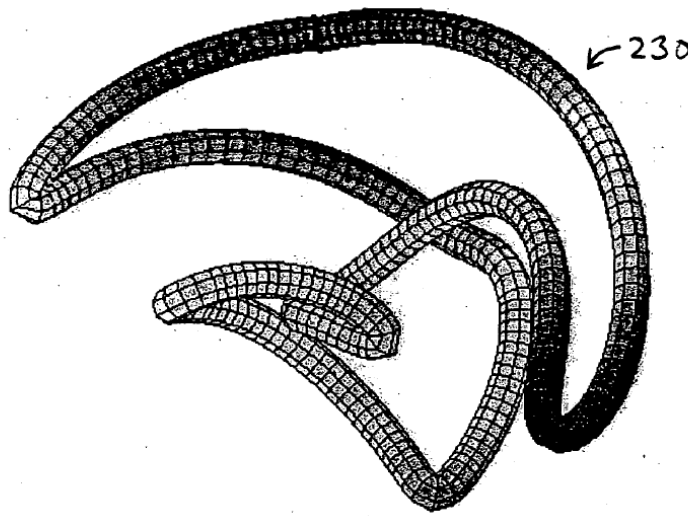


FIG. 23

Id., Fig. 23 (illustrating a 3D path that can be displayed to user).

129. “FIG. 24 shows an example of a display that includes a 3D rendering of a colon 240, a pre-surgery planned path 241 for the endoscope, and the actual path 242 taken by the endoscope (which may be determined in real-time or based on previously recorded movements of the scope).” *Id.*, ¶0135.

sensor. Gattani discloses that display of portions of the body can be generated to match to the viewpoint determined by the position of the distal tip 6 of the scope 1:

As noted above, the tracking subsystem 42 can automatically detect movements of the flexible endoscope during an endoscopic procedure. Specific techniques and apparatus for detecting the current position and orientation of the scope are described below. In response to scope movements, the data processing subsystem 44 can also automatically identify a particular slice of intra-operative or pre-operative scan data corresponding to the current location and orientation of the endoscope tip and cause an image of that slice to be displayed to the user from the viewpoint of the scope tip or another viewpoint, and in the same way cause other slices of intra-operative or pre-operative scan data to be identified and displayed automatically in response to further movements of the endoscope during the procedure.

Id., ¶0096; *see also*, ¶¶0090 (describing “[a] rendering window that includes a volumetric perspective image, based on scan data, rendered from a point of view that correlates to the outputs of the position/orientation sensors attached to the endoscope (i.e., the endoscopic camera point of view)”), ¶0097.

C. Claim 9

132. Gattani anticipates claim 9.

1. **[9.0] 9. The scanning system according to claim 1, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.**

133. Gattani discloses wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display. As discussed in [5.0] of this Ground, the viewing angle of the images

displayed on the screen are automatically changed based on movements of the scope. *Id.*, ¶0096 (“cause an image of that slice to be displayed to the user from the viewpoint of the scope tip or another viewpoint”); *see also*, ¶0090, ¶0097. As discussed in [1.2] of this Ground, the position of the scope is controlled by the user. *Id.*, ¶¶0054-55.

D. Claim 18

134. Gattani further anticipates claim 18.

- 1. [18.0] 18. The scanning system according to claim 1, wherein audible information is provided to the operator.**

135. Gattani discloses wherein audible information is provided to the operator. Gattani describes that “the VNS 30 may also output synthesized speech and/or other forms of audible output (e.g., warnings or distance to target) to the user through an audio speaker 36.” *Id.*, ¶0059.

E. Claim 22

136. Gattani anticipates claim 22.

- 1. [22.0] 22. The scanning system according to claim 1, wherein the system comprises at least two motion sensors and wherein the at least two motion sensors provide sensor fusion.**

137. Gattani discloses wherein the system comprises at least two motion sensors and wherein the at least two motion sensors provide sensor fusion. The ’221 patent does not define “sensor fusion,” but generally, sensor fusion is the combining of sensor outputs from different sensor groups or modalities into a single

measurement, which is an improved measurement in accuracy, noise, lag, drift, speed or combination utilizing the qualities of each sensor for overall improved tracking performance. For example, if both electromagnetic sensors and optical sensors are used to determine the position and orientation of a medical instrument then a correlated set of position and orientation values from the electromagnetic sensors and the optical sensors would be fused by using a model to produce a single set of values that describe the position and orientation of the medical instrument.

138. The “hybrid approach” described in Gattani is a sensor fusion approach that uses two sensors: one on the base uses LEDs and cameras to compute position and orientation of the base 4 and one on the distal tip that uses fiber optic curvature sensors. The fusion process is described succinctly in Figure 15:

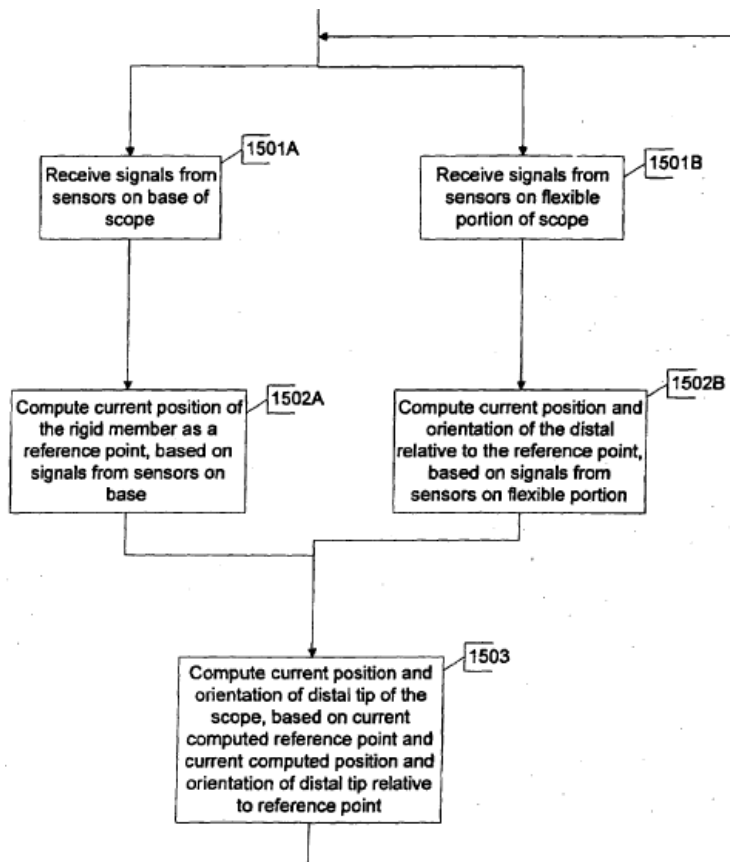


Fig. 15

At 1503, Figure 15 of Gattani generally describes the model that will be used to compute a position and orientation of the distal tip of the scope 1. As described, the model uses the relative relationship between a measured position and orientation of the distal tip 6 and a measured position and orientation of the base 4, with the position and orientation of the base 4 used as a reference point to determine the current position and orientation of the distal tip 6. The reference point of the rigid member (*i.e.*, base 4) referred to in Figure 15 contains both position and orientation information. *Id.*, ¶¶0105, 0111.

139. Because the model uses the “current computed reference point” and the “current computed position and orientation of the distal tip relative to the reference point,” Gattani discloses at least two motion sensors wherein the at least two motion sensors provide sensor fusion. The first motion sensor is the “the position/orientation sensors or LEDs 112 on the base 4 of the scope and obtains the current computed reference point. *Id.*, ¶0111. The second motion sensor is “the position orientation sensors 120 on the flexible portion 5 of the scope 1[,]” and obtains the position and orientation of the distal tip by using a different tracking method of fiber optic curvature sensors. *Id.* Because each of the motion sensors detect both position and orientation, both sensors are motion sensors within the scope of the claims. The ’221 patent explains that optical sensors can be motion sensors. EX1001, 10:62-11:3.

140. At least optical sensors of the base 4 of the hybrid approach directly detect motion. The optical sensors directly detect motion when they determine the position and orientation of the base 4 from observed light. EX1105, ¶¶0105, 0111. Using optical sensor on the base 4 of Gattani, a POSA would understand that position and orientation measurements would be acquired by these sensors at discrete and consecutive sample times, any change or absence of change between two consecutive samples is a direct indication of motion between the consecutive

samples. Therefore, consistent with the '221 patent, motion is directly detected by the optical sensors on the base 4 of Gattani.

F. Claim 23

141. Gattani anticipates claim 23.

1. **[23.0] 23. The scanning system according to claim 1, wherein the at least one motion sensor is the 3D user interface for remotely controlling the display, wherein the view on the display is determined by moving the handheld scanner.**

142. Gattani discloses wherein the at least one motion sensor is the 3D user interface for remotely controlling the display, wherein the view on the display is determined by moving the handheld scanner. As discussed in [1.6] and [5.0] of this Ground, Gattani uses sensors 104 as a 3D user interface for controlling the display, and when the distal tip of scope is moved, the view on the display is determined by that movement. *Id.*, ¶¶0090 (“[a] rendering window that includes a volumetric perspective image, based on scan data, rendered from a point of view that correlates to the outputs of the position/orientation sensors attached to the endoscope (i.e., the endoscopic camera point of view)”), 0096-97.

G. Claim 24

143. Gattani anticipates claim 24.

1. **[24.0] 24. The scanning system according to claim 23, wherein moving the handheld scanner to point down causes the view on the display to be a downward viewing angle.**

144. Gattani discloses wherein moving the handheld scanner to point down causes the view on the display to be a downward viewing angle. Gattani discloses, “the technique which will now be introduced provides six degree of freedom for visual navigation of endoscopic video. In effect, this technique allows the user control of a virtual camera (point of view) that can be translated in three orthogonal axes in 3-D space as well as allowing control of vertical panning (pitch), horizontal panning (yaw) and tilt (roll) of the virtual camera, as well as zoom.” *Id.*, ¶0113; *see also*, [1.5] of this Ground. Thus, one of ordinary skill in the art would understand that if the probe tip is pointed down, the view on the display is a downward viewing angle. *Id.*, ¶0090 (“[a] rendering window that includes a volumetric perspective image, based on scan data, rendered from a point of view that correlates to the outputs of the position/orientation sensors attached to the endoscope (i.e., the endoscopic camera point of view)”).

H. Claim 25

145. Gattani anticipates claim 25.

1. [25.0] 25. The scanning system according to claim 1, wherein the handheld device further comprises a user-interface element.

146. Gattani discloses wherein the handheld device further comprises a user-interface element. As discussed in [1.5] of this Ground, in Gattani, “[t]he distal tip 6 of the scope 1 is part of the flexible portion 5 and can be flexed about two or more

orthogonal axes by the surgeon, by using controls (not shown) mounted on the base 4.” *Id.*, ¶0054; *see also*, ¶¶0093 (“camera controls”), 0125 (“button”).

147. Similarly, Gattani explains that a “set of points needed to fit the implicit function are initially collected by the user’s pressing a predetermined control input (e.g., pressing a designated button on the scope 1 or the endoscopic video camera 9).” *Id.*, ¶0125.

148. Each of these buttons and controls are user interface elements because they allow a user to interact with the system of Gattani.

I. Claim 26

149. Gattani anticipates claim 26.

1. **[26.0] 26. The scanning system according to claim 25, wherein the user-interface element comprises a touch-sensitive element, a button, a scroll-wheel, or a proximity sensor.**

150. Gattani discloses wherein the user-interface element comprises a touch-sensitive element, a button, a scroll-wheel, or a proximity sensor. As discussed in [25.0] of this Ground, the scope 1 includes a button: “The set of points needed to fit the implicit function are initially collected by the user's pressing a predetermined control input (e.g., pressing a designated button on the scope 1 or the endoscopic video camera 9).” *Id.*, ¶0125.

J. Claim 28

151. Gattani anticipates claim 28.

1. [28.0] 28. The scanning system according to claim 25, wherein the at least one motion sensor and/or the user-interface element are utilized in a workflow.

152. Gattani discloses wherein the at least one motion sensor and/or the user-interface element are utilized in a workflow. Although not defined by the ‘221 patent, a POSA would understand the plain meaning of “workflow” to be a series of steps performed to achieve an objective. Gattani discloses a workflow for determining an implicit function that uses the at least one motion sensor. *Id.*, ¶¶0122-25. In that workflow, the button on the scope 1 is used to determine a set of points. *Id.*, ¶0125 (“The set of points needed to fit the implicit function are initially collected by the user’s pressing a predetermined control input (e.g., pressing a designated button on the scope 1 or the endoscopic video camera 9) when the tracked distal tip 6 of the scope is touched to three or more locations of the surface of the anatomical feature of interest, such as locations 202, 203 and 204 on the surface of the polyp 201 shown in FIG. 20 illustrates an endoscopic camera view of a polyp.”). The designated button on the scope 1 is a user interface element utilized in a workflow.

153. Figure 20 is reproduced below:

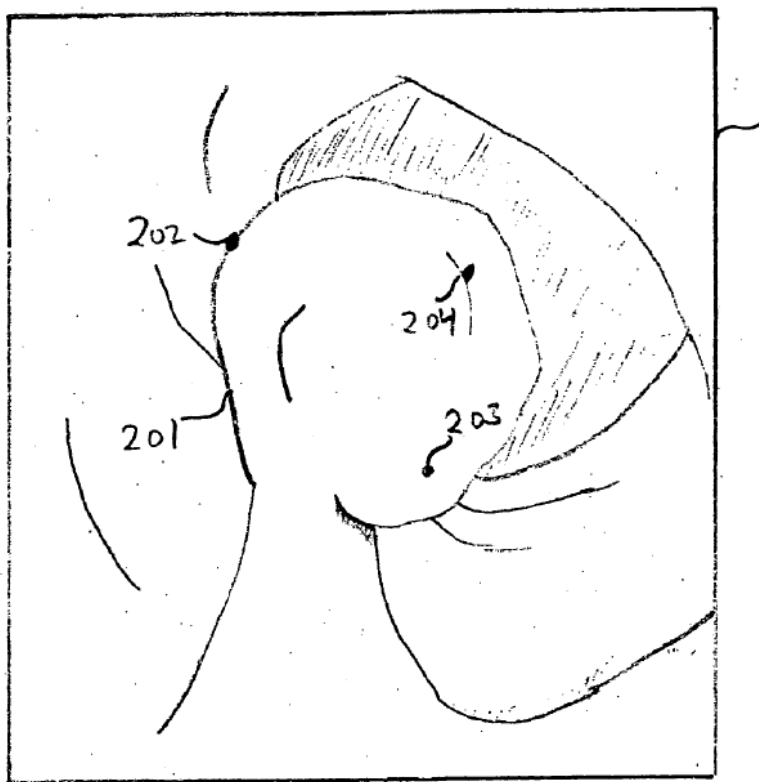


FIG. 20

By completing the workflow whereby the surgeon presses the control input at each of the location 202, 203, and 204, an implicit function or model can be created and displayed to a user. The full workflow is illustrated in Figure 21:

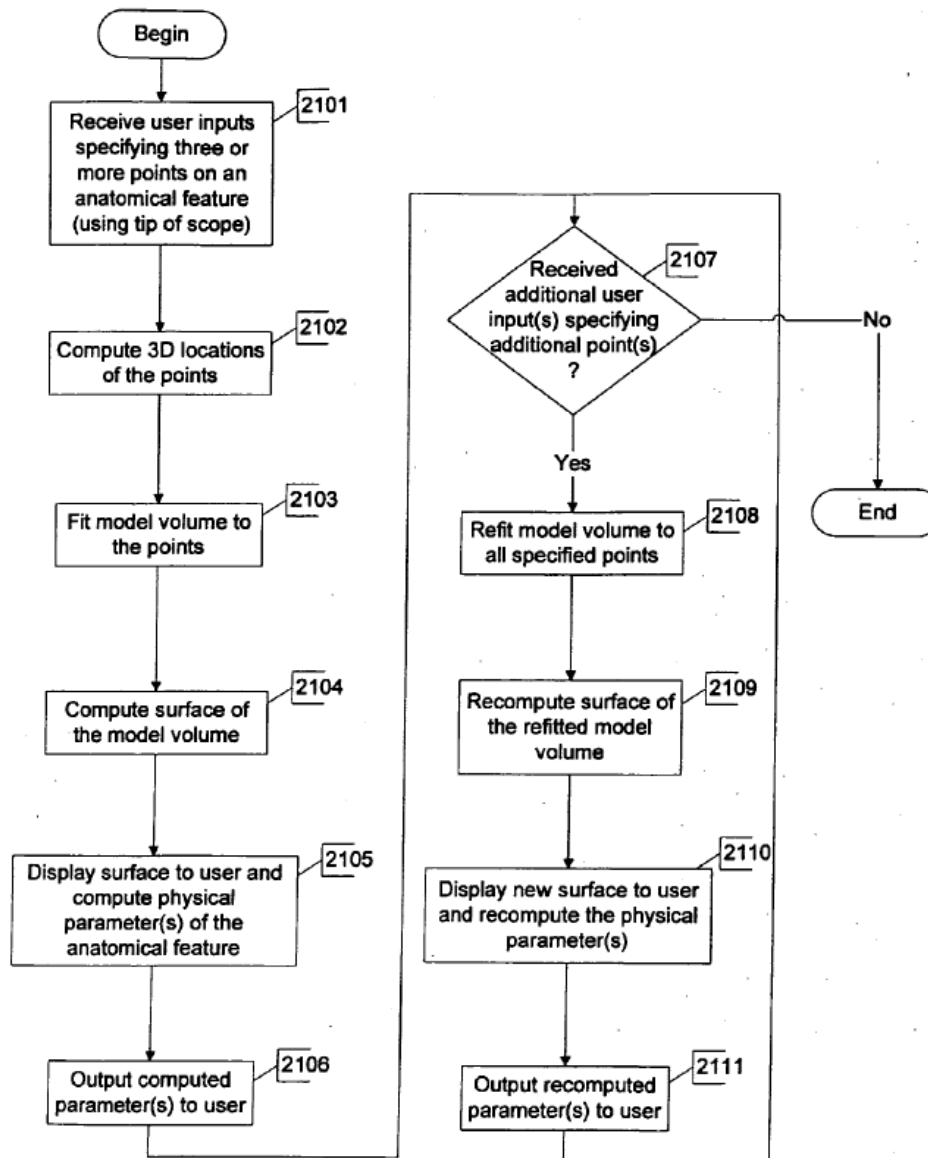


Fig. 21

K. Claim 31

154. Gattani anticipates claim 31.

1. [31.0] 31. The scanning system according to claim 1, wherein the at least one display is divided into multiple regions.

155. Gattani discloses wherein the at least one display is divided into multiple regions. As illustrated in Fig. 2 below, the display 20 is divided into regions 21, 22, and 23.

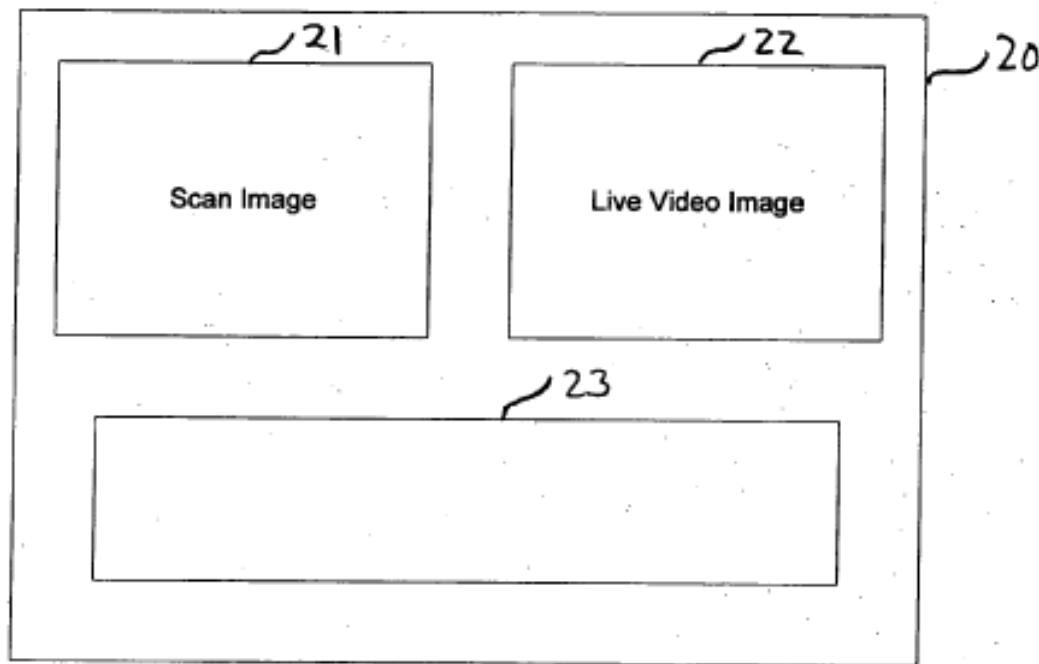


Fig. 2

Id., Fig. 2.

156. Gattani explains that, “[a]s shown in FIG. 2, a display 20 generated by the includes several windows in proximity to each other, including a window 21 that contains a scan image and a window 22 that contains a corresponding live video image, presented side-by-side.” *Id.*, ¶0064. Gattani further explains, “[o]ther data,

such as text, graphics, touch screen controls, etc., can be included on a separate portion 23 of the display 20.” *Id.*, ¶0057.

L. Claim 33

157. Gattani anticipates claim 33. Labels (*i.e.*, [33.0]) have been appended to the claim limitations for ease of reference.

1. [33.0] 33. A scanning system for scanning a 3D environment, the scanning system comprising:

158. Gattani discloses a scanning system for scanning a 3D environment. *See* [1.0] of this Ground.

2. [33.1] a handheld device including an optical scanner

159. Gattani discloses a handheld device including an optical scanner. *See* [1.1] of this Ground.

3. [33.2] wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment

160. Gattani discloses wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment. *See* [1.2] of this Ground.

4. [33.3] at least one display remotely connected to the handheld device

161. Gattani discloses at least one display remotely connected to the handheld device. *See* [1.2] of this Ground.

5. [33.4] wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment

162. Gattani discloses wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment. *See* [1.3] of this Ground.

6. [33.5] the at least one display is adapted for visually representing the physical 3D environment

163. Gattani discloses the at least one display is adapted for visually representing the physical 3D environment. *See* [1.4] of this Ground.

7. [33.6] wherein the handheld device includes at least one motion sensor for remotely controlling the display to adjust the view with which the 3D environment is represented on the display

164. Gattani discloses wherein the handheld device includes at least one motion sensor for remotely controlling the display to adjust the view with which the 3D environment is represented on the display. *See* [1.5] and [1.6] of this Ground.

8. [33.7] wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer.

165. Gattani discloses wherein the at least one motion sensor is a magnetometer. *See* [1.6] of this Ground. The inductive loop sensors of Gattani are magnetometers because they measure a local magnetic field generated by a field generator—“Referring that FIG. 10, in accordance with a first embodiment, an electromagnetic field generator is used as the center of the tracked volume and is hence placed under the patient table 101 at a configurable location. The location of the generator constitutes the origin 102 of the tracking system. In certain

embodiments, each sensor 104 on the scope 1 contains three small wire coils (not shown) oriented perpendicular to each other. The electromagnetic field 103 generated by the generator induces current through these coils. The currents in these coils at any particular instant in time is dependent upon the electromagnetic field strength at the location of the sensor and the orientation of the sensor relative to the generator.” *Id.*, ¶0100, Fig. 10.

IX. GROUND 2: CLAIMS 1-3, 5-7, 9-11, 15, 18-21, 23-28, 31-34, 40-44 ARE OBVIOUS OVER KRIVESHKO, SERRA, AND HOPKINS

A. Claim 1

166. Claim 1 is obvious in view of the combination of Kriveshko, Serra, and Hopkins.

1. [1.0] A scanning system for scanning a 3D environment, the scanning system comprising:

167. Kriveshko discloses a scanning system for scanning a 3D environment. Kriveshko is titled, “Three-Dimensional Scan Recovery.” EX1106, Kriveshko, Title. Kriveshko describes the disclosed system as “[a] scanning system that acquires three-dimensional images.” *Id.*, Abstract. In Fig. 1, Kriveshko illustrates a scanner 102 (part of a scanning system) scanning a subject 104 (a 3D environment):

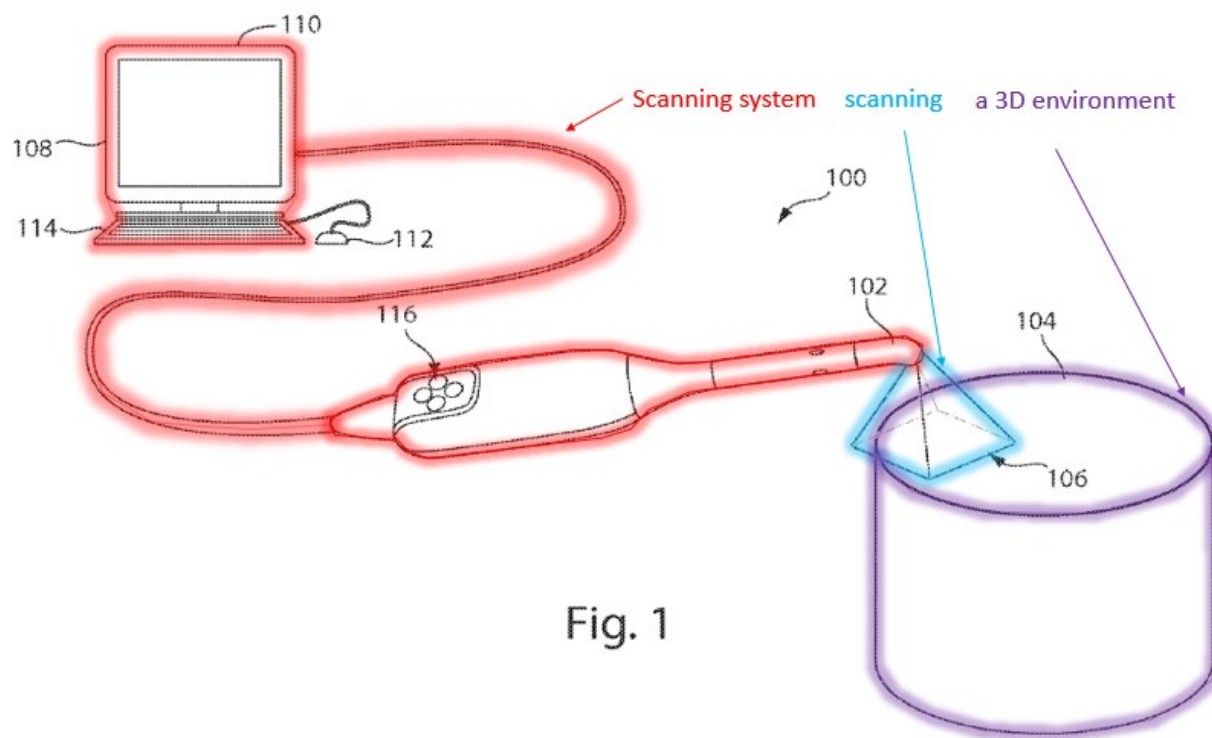


Fig. 1

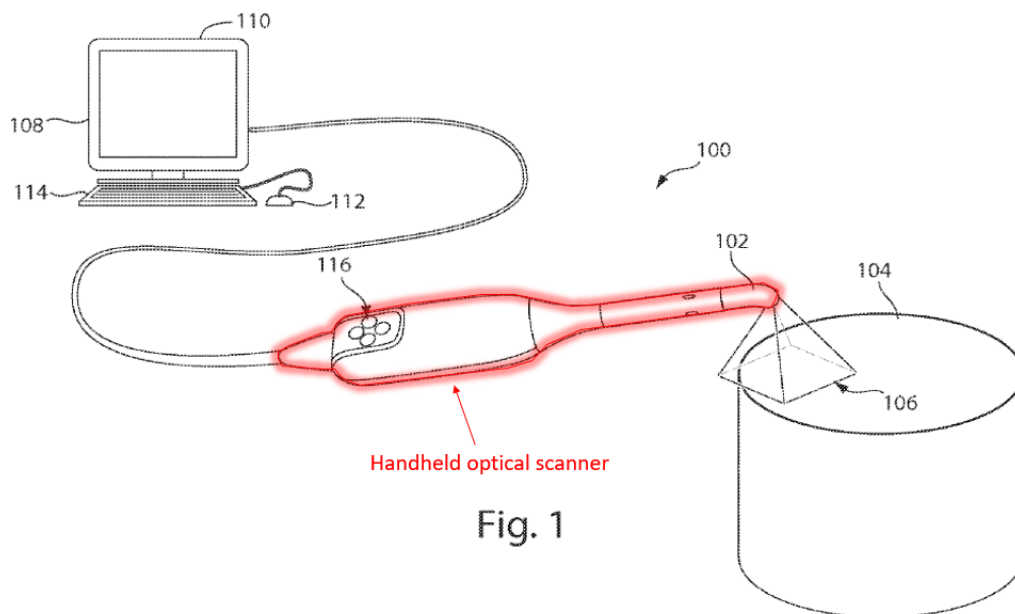
168. Kriveshko explains that, “[i]n general, the system 100 may include a scanner 102 that captures images of a subject 104 within an image plane 106, and forwards the images to a computer 108, which may include a display 110 and one or more user input devices such as a mouse 112 or a keyboard 114.” *Id.*, ¶0051. Kriveshko explains that, “in a dental imaging application, the subject 104 may include a tooth, a quadrant of teeth, or a full collection of teeth. . .” *Id.*, ¶0054. Thus, a POSA would have understood the subject 104 to correspond to the claimed 3D environment.

169. The disclosure of Kriveshko is generally directed to obtaining scans of a 3D environment, via a scanning system including a scanner, to derive, display, and manipulate 3-dimensional data. *See, e.g., id.*, ¶¶0002, 0049 (“three-dimensional

scanning device”), 0052 (“[t]he scanner 102 may include suitable processing for deriving a three-dimensional point cloud from an image set or a number of image sets, or each two-dimensional image set may be transmitted to an external processor”), 0058, 0060 (“FIG. 2 depicts a process for three-dimensional scanning.”), 0090 (“FIG. 4 depicts a view of a user interface for an image capture system.”); *see also*, Figs. 1, 2, and 4-9.

2. [1.1] a handheld device including an optical scanner

170. Kriveshko discloses a handheld device including an optical scanner. The scanner 102 in Kriveshko is a handheld device including an optical scanner. Kriveshko describes the scanner 102 as “a handheld, freely positionable probe having at least one user input device, such as a button, lever, dial, thumb wheel, switch, or the like, for user control of the image capture system 100.” *Id.*, ¶0052.



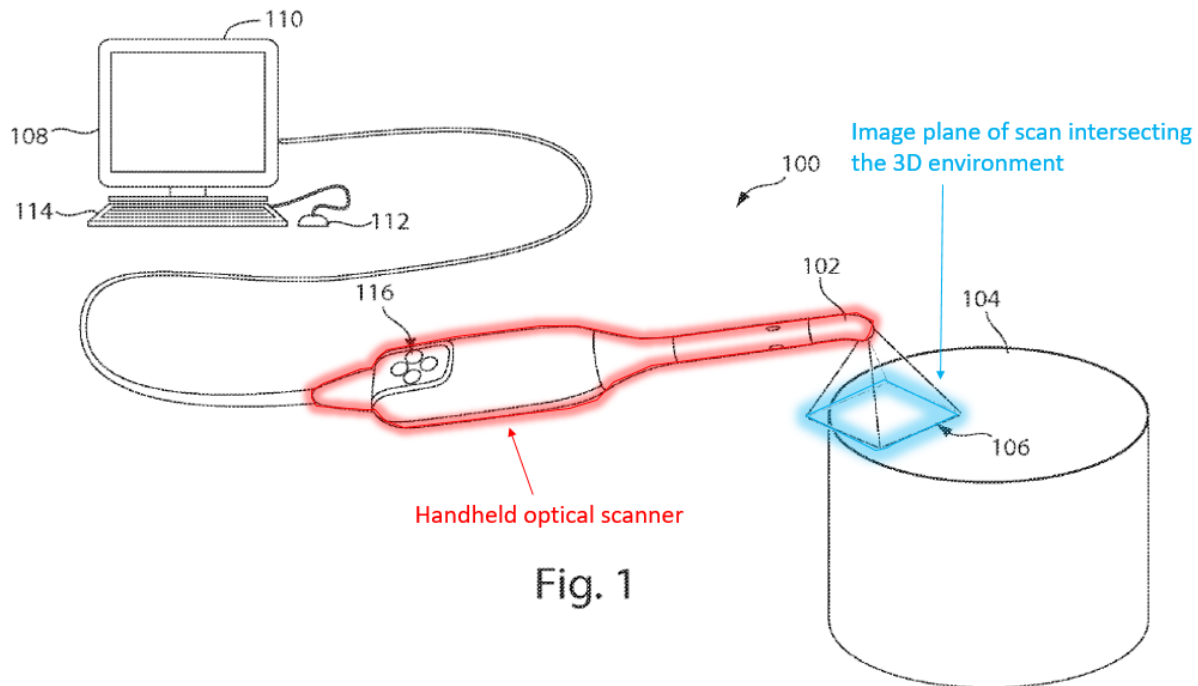
Id., Fig. 1.

171. In ¶0052, Kriveshko describes numerous optical scanning embodiments. For example, Kriveshko discloses that “[t]he scanner 102 may include any camera or camera system suitable for capturing images from which a three-dimensional point cloud may be recovered,” further describing that, “the scanner 102 may include a plurality of apertures including a center aperture positioned along a center optical axis of a lens and any associated imaging hardware.” *Id.*, ¶0052.

172. Based on the disclosure above taken alone and in view of the discussion in [1.0] of this Ground, a POSA would have understood that the handheld scanner 102 of Kriveshko includes an optical scanner.

3. [1.2] wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment; and at least one display remotely connected to the handheld device

173. Kriveshko discloses wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment. I discussed scanning, optical scanners, and 3D environments in [1.0] and [1.2] of this Ground. Figure 1 illustrates the scanner 102 pointed at the subject 104 for the purpose of scanning:



174. Kriveshko describes that “scanner 102 that captures of a subject 104 within an image plane 106, and forwards the images to a computer 108.” *Id.*, ¶0051). Given the image plane 106, a POSA understands that Kriveshko discloses selecting a 3D environment to be scanned by pointing the scanner at the 3D environment.

175. The scanner 102 of Kriveshko is remotely connected to the display of the computer 108. “Communications between the computer 108 and the scanner 102 may use any suitable communications link including, for example, a wired connection or a wireless connection based upon, for example, IEEE 802.11 (also known as wireless Ethernet), BlueTooth, or any other suitable wireless standard using, e.g., a radio frequency, infrared, or other wireless communication medium.” *Id.*, ¶0057.

4. [1.3] wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment

176. Kriveshko discloses wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment. Again, Kriveshko discloses, “a scanner 102 that captures images of a subject 104 within an image plane 106.” *Id.* I have discussed 3D environments above, and a POSA would understand the subject 104 to be a *physical* 3D environment for the same reasons I discuss in [1.0] of this Ground.

177. Kriveshko is *adapted for* performing various scanning actions in a 3D environment. *See, e.g., id.*, ¶¶0052 (describing various scanner embodiments for scanning); 0055 (describing various image plane geometries); 0060-76 (describing numerous processes for scanning); 0077-0089 (describing various recovery mode processes for scanning).

178. Fundamentally, Kriveshko discloses, “[t]he scanner 102 may include any camera or camera system suitable for capturing images from which a three-dimensional point cloud may be recovered.” *Id.*, ¶0052. A POSA understands capturing images to be a scanning action.

5. [1.4] the at least one display is adapted for visually representing the physical 3D environment

179. Kriveshko discloses that the at least one display is adapted for visually representing the physical 3D environment. Specifically, Kriveshko discloses a

display 110 for visually representing the physical 3D environment. Kriveshko explains that, “the display 110 may show a video image of the subject 104, as viewed from the scanner 102. The computer may render the three-dimensional model, which may be a three-dimensional point cloud of surface data acquired for the subject 104, superimposed on the video image.” *Id.*, ¶¶0076; *see also*, 0060 (“a video image such as a video image of the subject from a position or point of view of the scanning device, may be rendered on the display 110[]”), 0080-82, 0100-01.

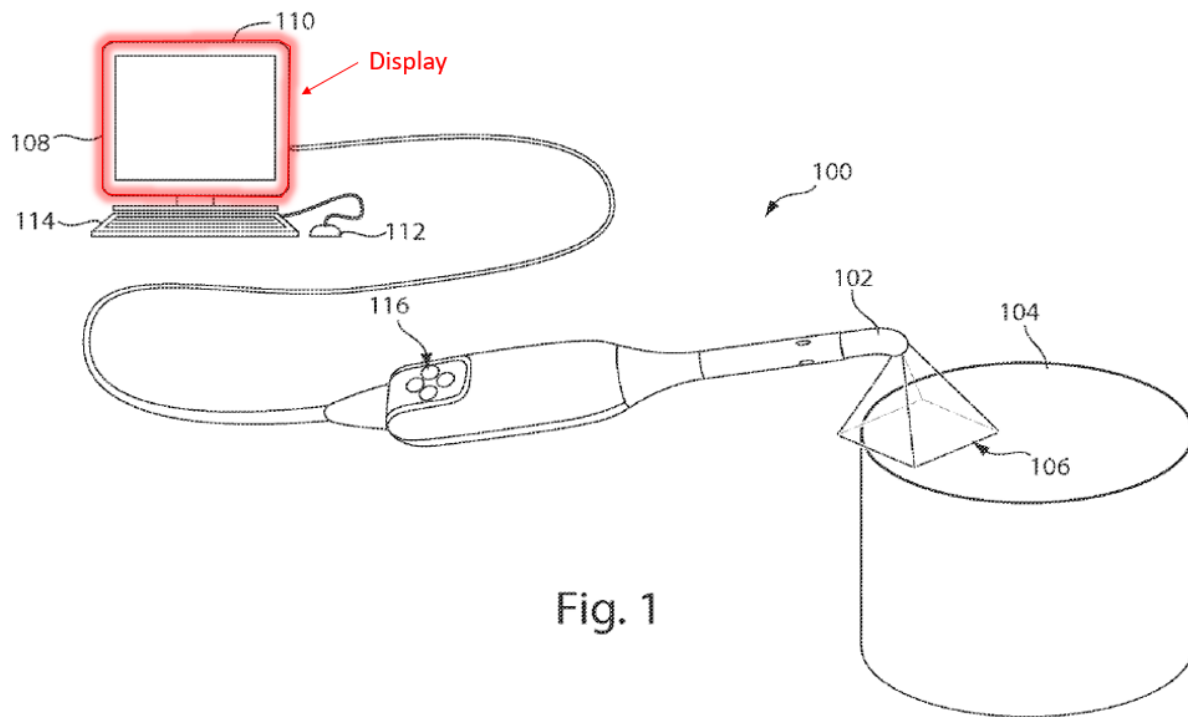


Fig. 1

Fig. 1 illustrates the display 110. Figs. 4-9 illustrate various views the subject that are presented on the display 110. *Id.*, ¶¶0090 (“FIG. 4 depicts a view of a user interface for an image capture system. The user interface 400 may include a window 402 rendered on a monitor such as the display 110 of FIG. 1.”), 0041 (“FIG. 5 depicts

a view of a user interface for an image capture system in an acquisition mode.”), 0042 (“FIG. 6 depicts a view of a user interface for an image capture system in an acquisition mode.”), 0043 (“FIG. 7 depicts a view of a user interface for an image capture system in a recover mode.”), 0044 (“FIG. 8 depicts a view of a user interface for an image capture system in a recover mode.”), 0045 (“FIG. 9 depicts a view of a user interface for an image capture system after reacquiring a scan.”). A POSA understands that each of the aforementioned figures depicts a visual representation of the subject 104 on the display 110. A POSA understands that both a video image and a 3D image are visual representations of the 3D environment.

6. [1.5] the handheld device includes a 3D user interface for remotely controlling the display to adjust the view with which the 3D environment is represented on the display

180. Kriveshko discloses a 3D user interface for remotely controlling a display to adjust the view with which the 3D environment is represented on the display. For example, Kriveshko discloses, “[w]ithin the field of view, a subject 404, such as the subject 104 of FIG. 1 may be displayed, along with one or more user controls 406.” *Id.*, ¶0090. Kriveshko further discloses, “the user controls 406 may generally include one or more controls for manipulating the three-dimensional model (e.g., rotating, scaling, panning, and the like), selecting a landing target, controlling operation of the image capture system (e.g., starting or stopping an acquisition), and so forth. The one or more controls may be manipulated, for

example, using any of the user input devices described above with reference to FIG. 1, including physical interaction with the monitor, where the display 110 includes a touchscreen.” *Id.*, ¶0091.

181. Kriveshko discloses a robust suite of image/view manipulation functions such as “rotating, scaling, panning, and the like” that can be initiated by a user using “user input device” *Id.* To the extent that it is argued Kriveshko’s suite of image/view manipulation function cannot be controlled via the scanner 102, Serra teaches performing image/view manipulation using the scanning device.

182. Serra discloses a system for acquiring 3D data via a scanning device in a scanning mode, and presenting the 3D data on a display. EX1107, Serra, ¶0012. Generally, Serra discloses, “[a] system and method for the imaging management of a 3D space where . . . a user can visualize images of a portion of a body or object . . . not just as 2D images, but as positionally and orientationally located slices within a particular 3D space.” *Id.*, Abstract. In particular, Serra discloses that the system “allows a user to manage the different images obtained...and to manipulate them as well as control various display parameters, for example, their visualization.” *Id.*, ¶0035.

183. Serra further discloses a 3D handheld scanning device that can control display parameters to interactively manipulate 3D data in an interactive visualization mode. *Id.*, ¶¶0053-0054. To that end, Serra further discloses, “one or more switches,

or other manual actuators, can be provided on or for a handheld probe to enhance 3D interactions,” and a user can “control display parameters by actuating one or more buttons on the probe...to rotate the entire virtual scene.” *Id.*, ¶¶0053. In addition, Serra discloses that the buttons of the scanning device may be used to switch between a scanning mode and an interactive visualization mode. *Id.*, ¶¶0053-0054.

184. Serra discloses a user can release a “button on the probe, and use the tracking information in the probe to rotate the entire scene and change the viewpoint of the user over the entire 3D scene.” *Id.*, ¶¶0054, 0074 (describing the sensor that obtains the tracking information).

185. Both Kriveshko and Serra are directed to 3D scanning and the display and interactive manipulation of 3D information. EX1106, ¶¶0051-52, 0060, 0090-91; EX1107, Abstract, ¶0054. With regard to interactive manipulation Kriveshko discloses that, “[t]he user controls 406 may generally include one or more controls for manipulating the three-dimensional model (e.g., rotating, scaling, panning, and the like)” which can be utilized by a “user input device,” and Serra discloses “use the tracking information” of a probe to rotate an entire scene which changes the viewpoint of the user over an entire 3D scene. EX1106 ¶0091; EX1107, ¶¶0004, 0037, 0051, 0053 (“a button can be used to indicate when to use the probe to scan real-time or when to use it to rotate the entire virtual scene, which is a common a 3D data set interactive visualization operation.”), 0054.

186. Kriveshko's scanning device 102 includes buttons. EX1106, ¶0052. Serra provides that it was well known in the art to modify a scanning device to control display parameters of 3D data presented on a display using one or more buttons of the scanning device in concert with the motion sensor of Serra. EX1107, ¶0053. Serra further explains that using auxiliary devices such as keyboards is awkward in a medical setting and has likely impeded the adoption of some 3D technologies. EX1107, ¶0009.

187. Given that Serra discloses that "[b]ecause a user is generally always holding the ultrasound (or other substantially real-time image acquisition) probe, it is ergonomically convenient to allow him to control display parameters by actuating one or more buttons on the probe[]," it would have been obvious to a POSA at the time of the invention to combine Kriveshko and Serra. *See* EX1107, ¶0053. Thus, a POSA would have found it obvious to improve the interactive manipulation of the system of Kriveshko by implementing Serra's controls (button switch/ 3D sensor) and processes for interactively manipulating 3D data presented on a display using a scanning device. In particular, a POSA would have found it obvious to modify the intraoral scanner system of Kriveshko to allow for manipulation of displayed 3D images using a 3D interface of the intraoral scanner. This is especially true because Serra explains that "[w]hat is further needed is an efficient and ergonomic interface that can allow a user to easily interact" with scan data." EX1107, ¶0011.

188. The 3D user interface of the combination is the 3D motion sensor of Serra which would have been obvious to include in the combination as discussed in [1.6] below. This understanding of 3D user interface is consistent with the '221 patent. EX1001, 6:64-66.

189. Based on the foregoing, POSA would have been motivated to combine Kriveshko and Serra in order to improve user interaction with 3D data via a 3D input device. Thus, it is my opinion that a POSA would have found it obvious to combine Kriveshko and Serra, especially because both references disclose handheld medical devices that use scans to create 3D images, to achieve the claimed “handheld device includes a user interface for remotely controlling the display to adjust the view with which the 3D environment is represented on the display.”

7. [1.6] wherein the handheld device comprises at least one motion sensor

190. The combination of Kriveshko and Serra discloses, “wherein the handheld device comprises at least one motion sensor.” Serra discloses, “an ultrasound probe with a 3D tracker.” EX1107, Serra, ¶0049. Serra further discloses, “the 3D position of the ultrasound probe 715 can be tracked by 3D tracker 703, by, for example, 3D sensor 720 which is attached to ultrasound probe 715.” *Id.*, ¶0074. Serra explains that, “in exemplary embodiments of the present invention this live image can be displayed as surrounded by the objects (i.e., the volumes from earlier ultrasound scans in the current session and/or the segmentations from other pre-

operative scans, as may be useful to a given user at a given time) in their correct positions and orientations” *Id.*, ¶0060; *see also id.*, claim 17 (“The system of claim 16, wherein the acquired ultra sound images are either 2D or 3D and are stored with a time stamp, size, orientation, position and color look-up table.”). As such, a POSA would understand Serra’s 3D sensor to be a motion sensor.

191. Serra’s motion sensor is critical to the implementation of the functionality of Serra discussed above in [1.5] above, and, therefore, this limitation is obvious for the same reasons discussed in [1.5] of this Ground.

8. [1.7] wherein the at least one motion sensor is a sensor that directly detects motion

192. The combination Kriveshko and Serra does not identify the type of sensor implemented as the “3D sensor 720” used to track the position and orientation of the scanner of the combination as discussed in [1.5] of this Ground. *Id.*, ¶0074. I believe that the combination, nonetheless, discloses, “wherein the at least one motion sensor is a sensor that directly detects motion” because it is disclosed that “3D sensor 720 . . . is attached to ultrasound probe 715.” *Id.* However, to the extent that Patent Owner argues that the 3D sensor 720 is a sensor that directly detects motion, in my opinion, Hopkins discloses such a sensor for use with an ultrasound probe.

193. Hopkins is titled “Ultrasound Probe with Accelerometer.” EX1108, Title. Hopkins explains, “[t]he accelerometer (32) is configured to detect the movement of the probe (10) in [] two to three axes when the probe (10) is rotated or

moved in a linear direction to allow the probe (10) to detect images from more than one plane.” *Id.*, Abstract. Hopkins further describes that, “[t]he accelerometers used with the probe of this invention can be a low cost analog devices.” *Id.*, 1:49-50.

194. A POSA would understand that an accelerometer is a motion sensor that directly detects motion. An accelerometer is a device that measures changes in gravitational or induced acceleration in one or more axes, typically three. Three axis accelerometers experiencing motion will report measured acceleration (rate of change of velocity) relative to the earth’s gravity or induced motion along each axis. In at least this respect, an accelerometer directly detects motion.

195. Hopkins explains, “[a]n accelerometer measures the non-gravitational acceleration it experiences. It is simplest to consider that the gravitational forces accelerate the whole accelerometer equally, and therefore give no reading. Non-gravitational acceleration is produced by forces other than gravity or inertial forces. Such forces include all simple mechanical forces. These are transmitted to the accelerometer device through mechanical stress on its mounting.” *Id.* at 3:13-20. An ultrasound probe having the accelerometer 32 of Hopkins is illustrated in Fig. 4 below:

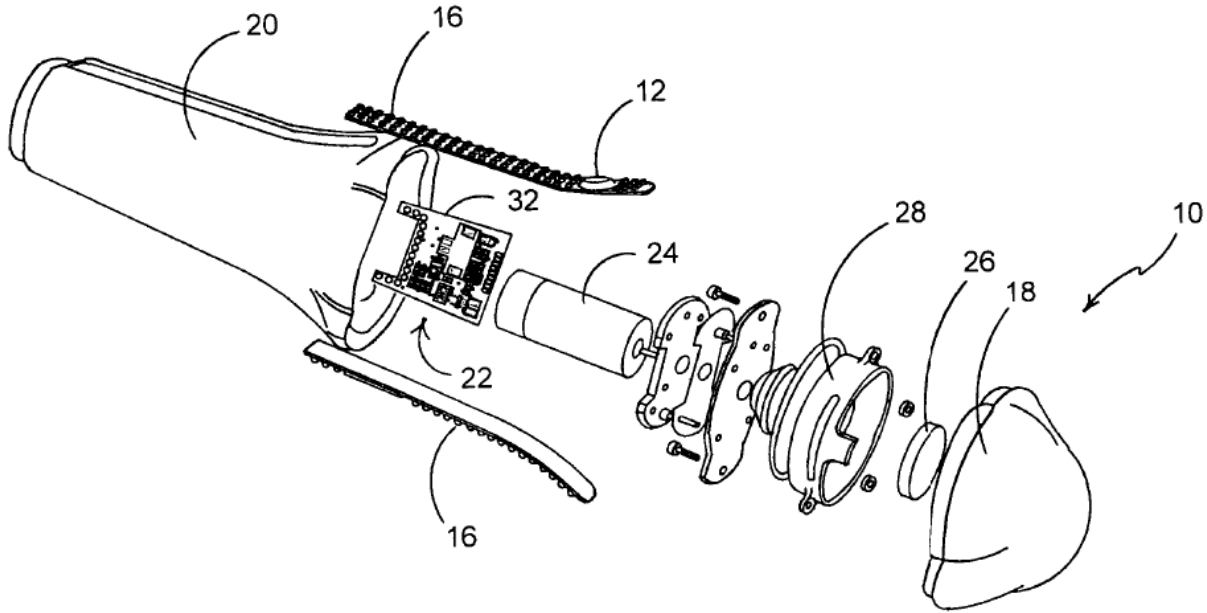


FIGURE 4

196. It would have been obvious to use the accelerometer of Hopkins as the 3D sensor 720 in the Kriveshko-Serra combination for a number of reasons. First, the application of accelerometers for 3D motion sensing was well-known. For example, Ferreira describes a “Tele-3D handheld 3D scanning system” from 2002 which uses “gyroscopes and accelerometers” to determine position and orientation. ¶3 C2, EX1023 at “3D Information Integration.” *See also* EX1008 (“Wiimote”), EX1021 (describing handheld device applications of motion sensing in 2002). Second, Hopkins describes that accelerometers can be implemented in handheld devices at low costs. *See id.*, at 1:49-50; *see also* EX1025, Petersen; EX1026, Shaw; EX1027, Nasiri. Based on the previous discussions it is my opinion that it would be easy and cost effective to implement the 3D sensor 720 of Serra as a 3-axis

accelerometer taught by Hopkins. Third, Serra specifically calls for “3D sensor 720 which is attached to ultrasound probe 715.” EX1107, ¶0074.

197. Thus, based on my experience, and because Kriveshko, Serra and Hopkins each related to handheld medical probe, because the accelerometers of Hopkins can be implemented at low cost, and because similar known devices implemented accelerometers to track position and orientation in medical devices, it is my opinion that it would have been obvious to a POSA to modify the combination of Kriveshko and Serra by Hopkins to build a scanning probe that has a 3D sensor that directly senses motion using a 3-axis accelerometer.

B. Claim 2

198. Claim 2 is obvious in view of the combination of Kriveshko, Serra, and Hopkins.

1. **[2.0] 2. The scanning system according to claim 1, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.**

199. Kriveshko discloses wherein the handheld device is adapted to record the 3D geometry of the 3D environment. Using the scanner 102, the system of Kriveshko can “capture approximately 1,500 points per image set in real time using the techniques described herein, and store an aggregated point cloud of over one million points. More generally, processing capabilities of the computer 108 may vary according to the size of the subject 104, the speed of image acquisition, and the

desired spatial resolution of three-dimensional points.” EX1106, Kriveshko, ¶0056, 0094 (“stored three-dimensional model”), 0095 (same), 0098 (same). A POSA understands that both three-dimensional points and three-dimensional models are 3D geometry of a 3D environment.

C. Claim 3

200. Claim 3 is obvious in view of the combination of Kriveshko, Serra, and Hopkins.

- 1. [3.0] 3. The scanning system according to claim 1, wherein the handheld device includes an actuator for manually switching between performing the at least one scanning action and remotely controlling the view.**

201. The combination of Kriveshko and Serra discloses wherein the handheld device includes an actuator for manually switching between performing the at least one scanning action and remotely controlling the view. In [1.5]-[1.7] of this Ground, the teachings of Kriveshko, Serra, and Hopkins are combined in known and logical ways to create a scanner that has the ability to control the view of display based on control of the scanner itself.

202. Serra discloses, “an ultrasound hand-held probe can operate in two modes of interaction, one in scanning mode (with button switch ON, for example) as in most ultrasound scanners, and the other in interactive mode (with the button switch in the alternate position, here OFF). The user can scan the patient by pressing

the ON button on the ultrasound probe and moving the probe over the region of interest.” EX1107, Serra, ¶0054.

203. Serra further discloses that, “[w]hat is further needed is an efficient and ergonomic interface that can allow a user to easily interact with ultrasound scan data as well as pre-operative imaging and planning data in three-dimensions.” *Id.*, ¶0011. Given Serra further explains the button switch for changing between scanning and interactive modes, “can free a user from having to continually move [from] the scanning area and interact with a separate interface on or within the ultrasound machine or the display,” it would have obvious to one of ordinary skill in the art to modify the intraoral scanning device of Kriveshko to include a button for switching between a scanning mode and an interactive mode which allows a user to manipulate a 3D view. *Id.*, ¶0053. Thus, Serra’s teaching of a button to actuate between a scanning action (button actuated “ON”) and an interactive mode for remotely controlling the view, in combination with Kriveshko and Hopkins, discloses the limitations of claim 3.

204. A POSA would have had a reasonable expectation of success in implementing a button that when manually actuated implements a function that switches between a scanning mode and an interactive mode which allows a user to manipulate a 3D view because associating functions with buttons was known long

before the priority date of the '221 and Serra explicitly disclose that function and its association with a button on a medical device.

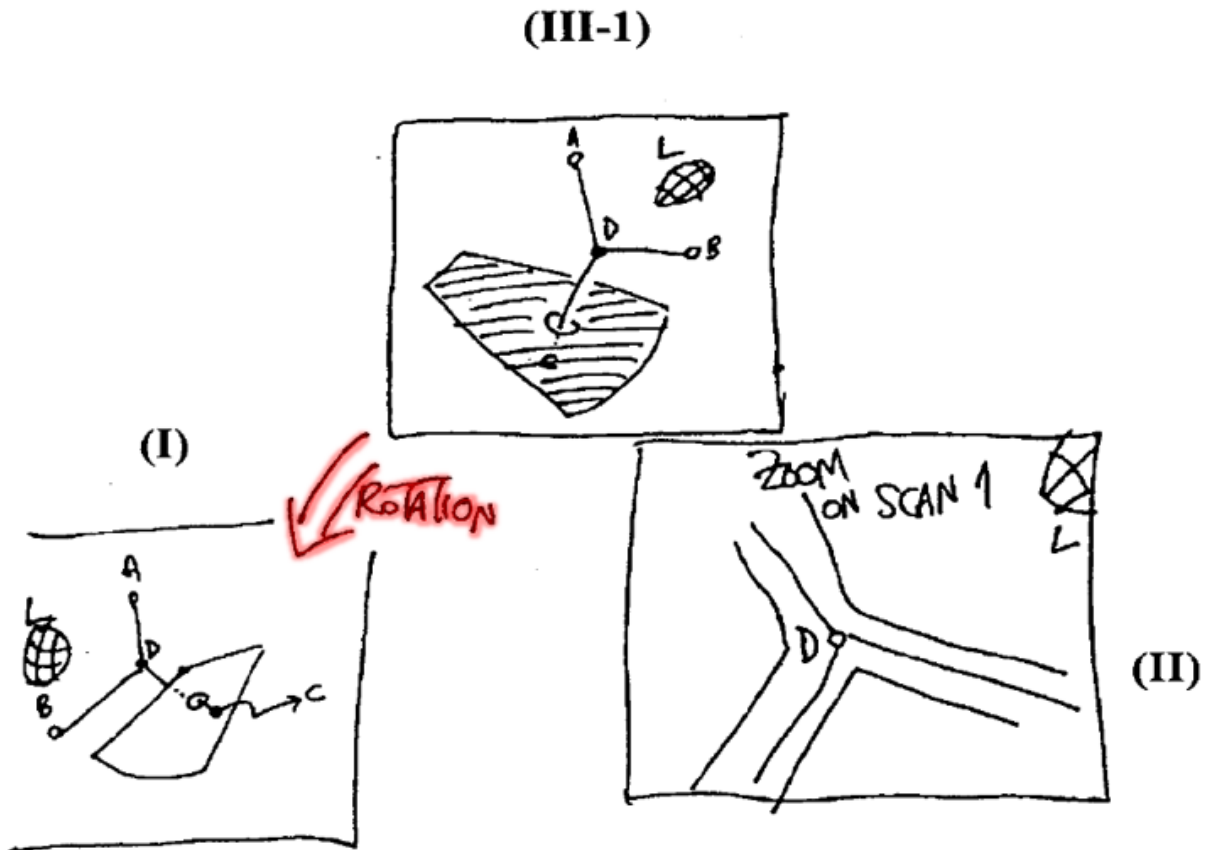
D. Claim 5

205. Claim 5 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[5.0] 5. The scanning system according to claim 1, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor.**

206. The combination of Kriveshko and Serra discloses wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor. In [1.5]-[1.7] of this Ground, Kriveshko and Serra are combined to create a scanner that has the ability to control the view of display based on detected movement of the scanning device. In that combination it was explained that Serra discloses that, “the user can release the button on the probe, and use the tracking information in the ultrasound probe to rotate the entire scene (effectively changing the viewpoint of the user over the entire 3D scene).” EX1107, Serra, ¶0054. In Serra, tracking information is position and orientation data produced by a 3D sensor 720. *Id.*, ¶¶0060, 0074, claim 17. Thus the combination of Kriveshko, Serra, and Hopkins in claim 1 of this Ground teaches wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor.

207. For example, view III-1 to I in Figure 5 illustrates the view rotation of Serra based on the 3D sensor attached to the scanning device (*i.e.*, the ultrasound probe). *Id.*, ¶¶0054, 0058.



208. It would have been obvious to improve Kriveshko with the ergonomic rotation capabilities Serra as discussed in [1.5] of this Ground and further so in view of Serra's disclosure that such rotation "reveal[s] detail not easily appreciated from the original scanning viewpoint," and "greatly enhanc[es] examination of a patient." *Id.*, ¶0058.

E. Claim 6

209. Claim 6 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[6.0] 6. The scanning system according to claim 1, wherein functionality of the 3D user interface comprises a use of gestures.**

210. The combination of Kriveshko, Serra, and Hopkins discloses, “wherein functionality of the 3D user interface comprises a use of gestures.” In the combination of Kriveshko, Serra, and Hopkins, discussed in [1.0]-[1.7] of this Ground, the user interface of Kriveshko is improved by Serra to have a scanning mode and an interactive mode where the user can freely manipulating the view on a display using the motion of an ultrasound probe.

211. It would have been obvious to improve the scanning mode of the combination using the gesture taught by Hopkins. In Hopkins, the gestures are 90 degree rotations of the probe. *See, e.g.*, EX1108, Hopkins, 3:56-61 (“The image shown in FIG. 6 are two scans taken at right angles to each other of the bladder of a person (Transverse and Sagittal planes). By using both images a more accurate valuation of the bladder volume can be made. By using the MEMS accelerometer 32 sensor the 90° turn in the probe 10 can be detected and the image automatically switched to the other window.”), 4:52-57 (“The sagittal scan can also be obtained automatically such that when the operator rotates the probe 10 by 90°. The MEMS 32 accelerometer sensor automatically senses when the probe 10 is rotated 90° to

automatically display the sagittal plane on the display either individually or side by side with the transverse scan[]”). Figure 6 is reproduced below:

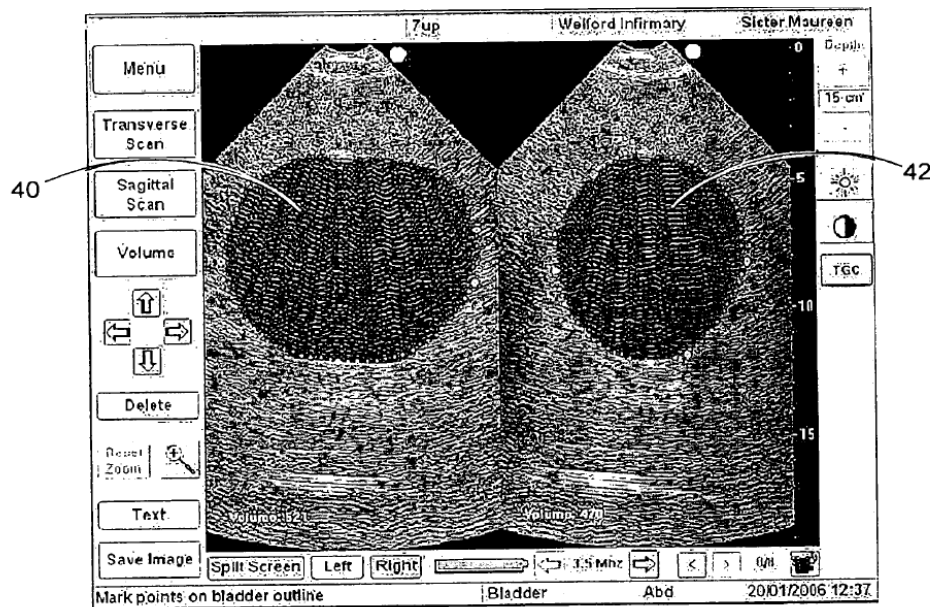


FIGURE 6

212. Kriveshko, Serra, and Hopkins share a common field of endeavor—3D scanning. It is my opinion that a POSA would have found it obvious at the time of the invention to improve the scanning mode capabilities of the combination of Kriveshko and Serra with the gestures of Hopkins to improve visual evaluation of objects from different perspectives. *See id.*, 4:52-57. A POSA would have readily been able to implement gestures for performing various functionality in the intraoral scanning device of the combination of Kriveshko, Serra, and Hopkins because the intraoral scanning device of the combination includes motions sensors and it was well within a POSA’s skill to use detected motion to trigger computer functionality. For example, Hopkins detects 90 degree rotations and triggers a scanning action as

discussed above. Implementing gesture functionality would require implementation of a simple software module that manipulates the display functionality based on predetermined sensor paths and image data.

F. Claim 7

213. Claim 7 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. [7.0] 7. The scanning system according to claim 6, wherein the gestures are detected by the at least one motion sensor.

214. The combination of Kriveshko, Serra, and Hopkins discloses wherein the gestures are detected by the at least one motion sensor. As discussed in [6.0] of this Ground, it would have been obvious to modify Kriveshko and Serra to include gesture based functionality based on the teachings of Hopkins. In Hopkins, the gestures are detected using an accelerometer. *Id.*, 4:52-57 (“The sagittal scan can also be obtained automatically such that when the operator rotates the probe 10 by 90°. The MEMS 32 accelerometer sensor automatically senses when the probe 10 is rotated 90° to automatically display the sagittal plane on the display either individually or side by side with the transverse scan[]”).

215. It is my opinion that it would have been obvious to detect the gestures using the motion sensor of Kriveshko and Serra for reasons discussed in [1.5]-[1.7]

and [6.0] of this Ground because it would have not been economical or needed to include separate motion sensors for detecting gestures.

G. Claim 9

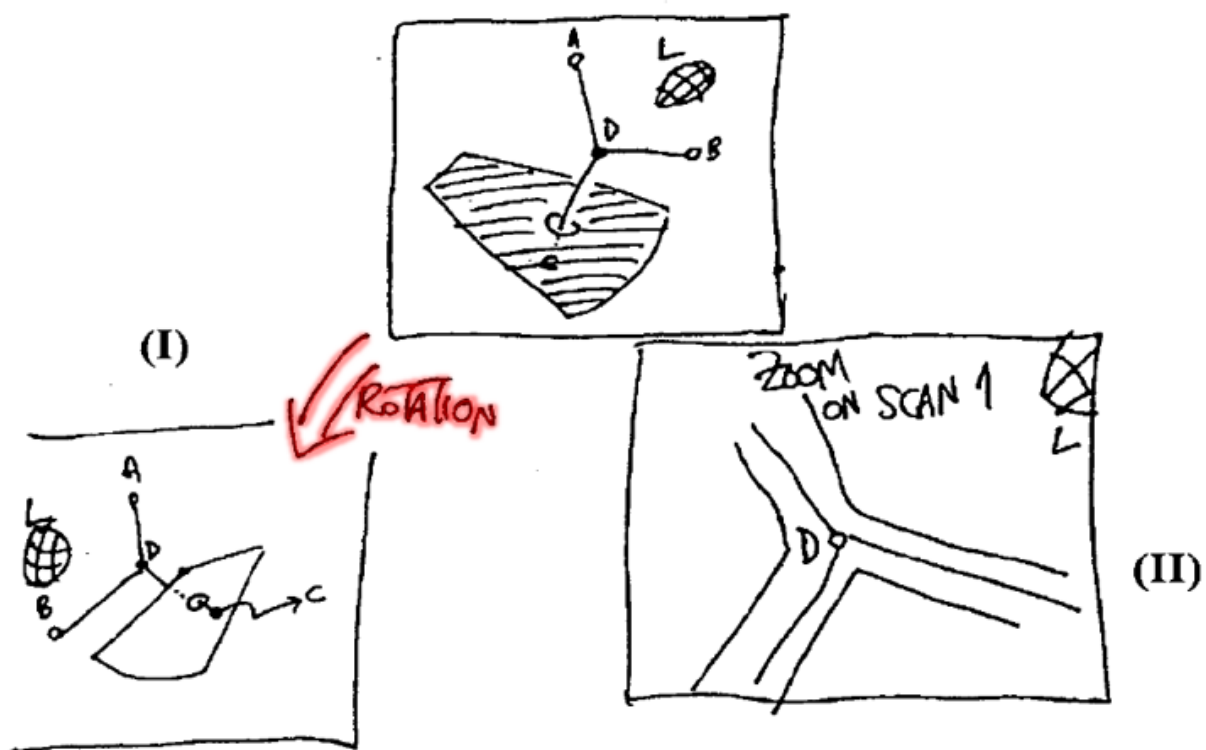
216. Claim 9 is obvious over the combination of Kriveshko, Serra, and Hopkins.

- 1. [9.0] 9. The scanning system according to claim 1, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.**

217. The combination of Kriveshko, Serra, and Hopkins discloses wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display. As discussed above in [1.5] of this Ground, Serra discloses using a scanning device to rotate an entire virtual scene. EX1107, ¶0051-54.

218. A POSA would understand Serra to disclose a handheld device adapted to change a viewing angle with which the 3D environment is represented on the at least one display: “Then, the user can release the button on the probe, and use the tracking information in the ultrasound probe to rotate the entire scene (effectively changing the viewpoint of the user over the entire 3D scene).” EX1107, ¶0054.

(III-1)



EX1107, Fig. 5 (illustrating rotation of the 3D scene) (annotated).

219. Thus, it would have been obvious to combine Kriveshko and Serra to arrive at the limitations of claim 9 for the same reasons I discuss in [1.5] and [5.0] of this Ground. Additionally, Serra teaches that the ability to change viewpoint offers “a point of view that is different from the viewpoint used during the scan . . . reveal[ing] parts that were obscured from the [original] viewpoint used during the scan.” EX1107, ¶0058.

H. Claim 10

220. Claim 10 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[10.0] 10. The scanning system according to claim 1, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.**

221. The combination of Kriveshko and Serra discloses wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display. Kriveshko discloses using controls on scanning device 102 to control magnification of what is displayed on the display. “FIG. 4 depicts a view of a user interface for an image capture system. The user interface 400 may include a window 402 rendered on a monitor such as the display 110 of FIG. 1. . . . The user controls 406 may generally include one or more controls for manipulating the three-dimensional model (e.g., rotating, Scaling, panning, and the like). . .” EX1106, ¶¶0090-91.

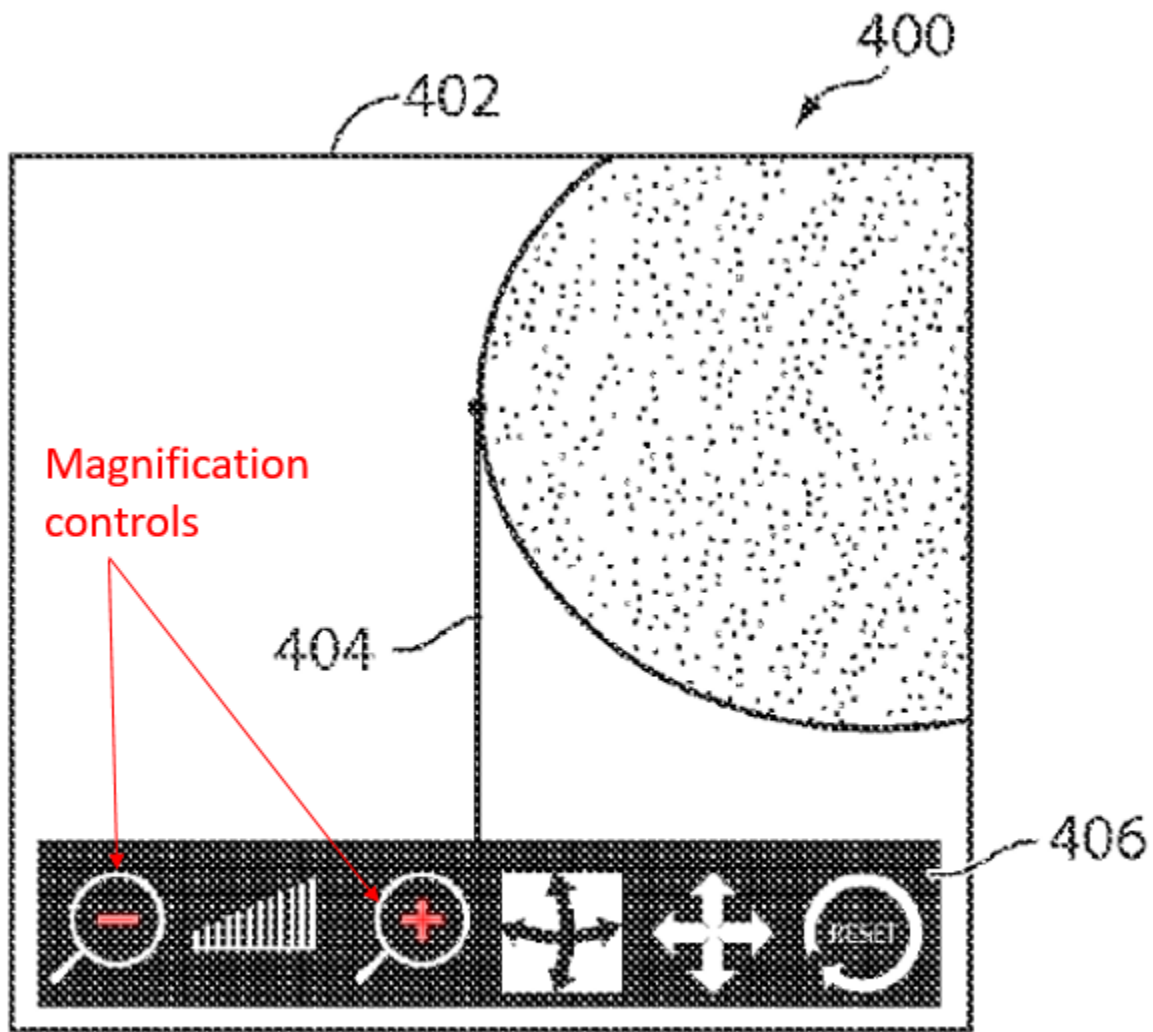


Fig. 4

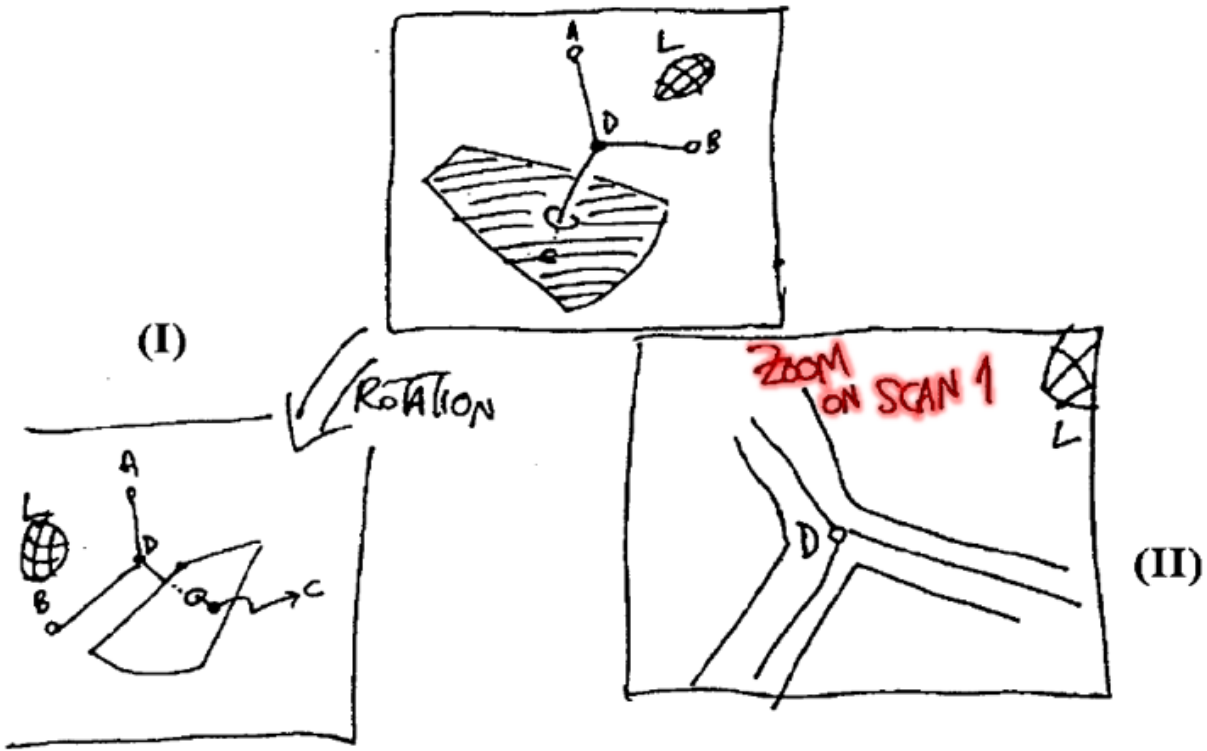
Id., Fig. 4.

222. Kriveshko further discloses, “[t]he computer 108 may generate control signals to the scanner 102 which, in addition to image acquisition commands, may include conventional camera controls such as focus or zoom.” *Id.*, ¶0057. A POSA would understand “zoom” to be a method “controlling operation of the image

capture system (e.g., starting or stopping an acquisition).” *Id.*, ¶0091. This understanding is reinforced by the use of the -/+ magnifying glasses in Figure 4 reproduced above.

223. However, to the extent it is argued that the Kriveshko does not disclose using the scanner 102 to change the magnification, although a POSA should recognize “scaling” as another term for magnifying, on the display, such functions are ubiquitous and well-known in the art and also disclosed by Serra. “Once such a selection is made, the clinician can, for example, use the pen or other tracked handheld tool to control the way in which to see the objects by performing various 3D volumetric operations upon them, such as, for example, described in detail in Zoom Slider, Zoom Context and 3D Matching” EX1107, ¶0057. The zoom operation of Serra is illustrated by contrast between III-1 and II in Figure 5.

(III-1)



Id., Fig. 5.

224. A POSA would understand the zoom functionality of Serra to meet the limitations of claim 10. And, at the time of the invention, a POSA would have found it obvious to combine the Kriveshko and Serra to achieve the limitations of claim 10 in view of Serra's disclosure that zoom can "reveal detail not easily appreciated from the original scanning viewpoint," and "greatly enhance examination of a patient."

Id., ¶0058. A POSA knew how to magnify image data, and frequently did so, long before the priority date of the '221 patent.

I. Claim 11

225. Claim 11 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. [11.0] 11. The scanning system according to claim 1, wherein the handheld device is an intra-oral 3D scanner.

226. Kriveshko discloses wherein the handheld device is an intra-oral 3D scanner. A POSA would understand Kriveshko's implementation of the scanner 102 to scan teeth inside a mouth to mean that the scanner 102 is an intraoral scanner. For example, Kriveshko discloses, "[a] scan of the arch using the image capture system 100 described above may include a continuous scan of exposed tooth surfaces from within a dental patient's mouth, choosing any convenient location 1004 as a starting point, and continuing in a scan path 1006 that passes over any exposed regions, and concluding at another location 1008 on the exterior surface." EX1106, ¶0103.

J. Claim 15

227. Claim 15 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. [15.0] 15. The scanning system according to claim 1, wherein the at least one display is defined as a first display

228. The combination of Kriveshko, Serra, and Hopkins discloses wherein the at least one display is defined as a first display. This limitation is discussed in [15.1] below in the context of the "second display."

2. [15.1] where the system further comprises a second display

229. Kriveshko and Serra discloses where the system further comprises a second display. To the extent Kriveshko does not disclose the limitations of claim 15 insofar as they require a second display, in my opinion, a POSA would have found it obvious to modify Kriveshko to use a second display as disclosed by Serra.

230. Serra discloses the use of two displays: a first to display a two dimensional image produced by the scanner and second to display a three-dimensional rendering. EX1107, ¶¶0074-76 (“there will be a main monitor of the ultrasound scanner” and an “external box”), Figures 7, 8. Fig. 8 illustrates the dual monitor setup of Serra:

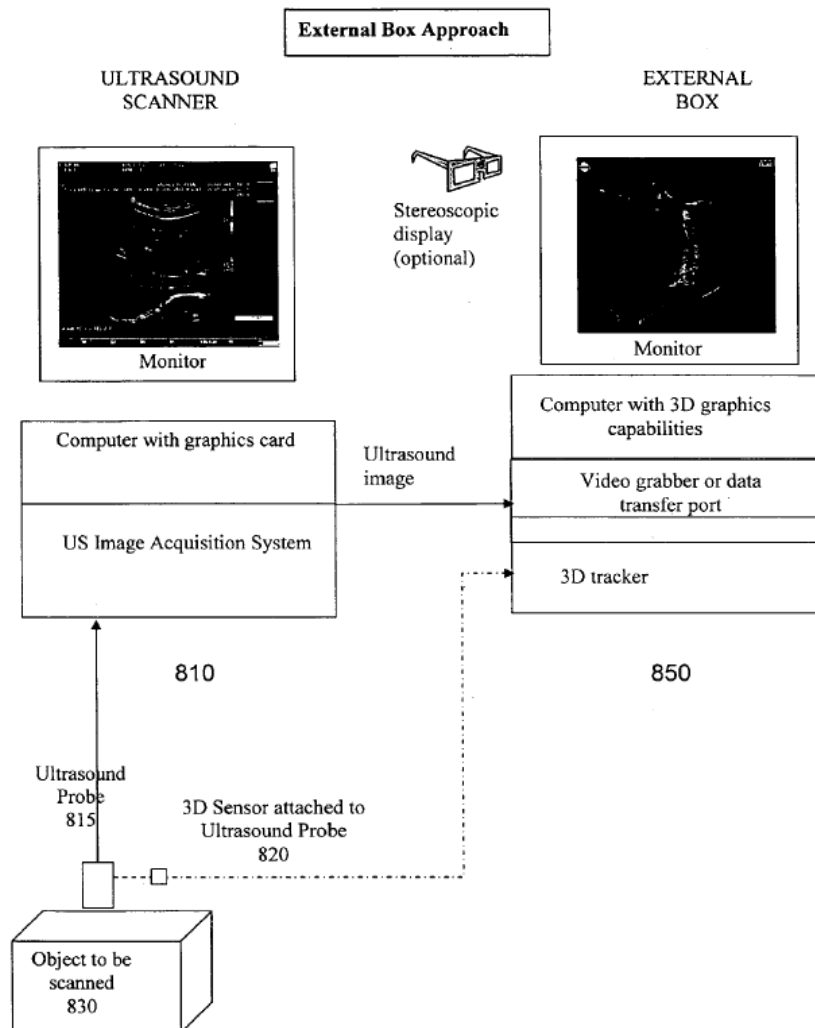


FIG. 8

231. The second display or “External Box” is a 3D display: “a box 850 external to the ultra sound scanner 810 that takes as an input the ultrasound image (either as a standard video signal or as a digital image), and provides as an output a 3D display.” *Id.*, ¶0075. Serra further discloses that the external box can be “an autostereoscopic display.” *Id.*, ¶0076. A POSA understands an autostereoscopic display generates 3D images without the use of external hardware such as glasses. *See also, Id.*

232. It would have been obvious to modify Kriveshko with Serra to utilize two displays for the reasons I discuss in [1.5] of this Ground and additionally because Serra describes that the benefit of providing a stereoscopic display is that it “afford[s] superior depth perception, which is the key to any 3D interface,” in addition to a conventional display. EX1107, ¶0046; *see also id.*, Figs. 7-8.

233. A POSA would have had a reasonable expectation of success in implementing multiple displays. For example, consistent with Serra, collected probe image could be displayed on a first screen while 3D image displayed on a second. Additionally, the use of multiple displays for displaying images, video, and the like was well known long before the priority date of the '221 patent.

K. Claim 18

234. Claim 18 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. [18.0] 18. The scanning system according to claim 1, wherein audible information is provided to the operator.

235. Kriveshko discloses wherein audible information is provided to the operator. A POSA would understand the verbal cues of Kriveshko to be audible information that is provided to the operator of the scanner 102: “It will be appreciated that other techniques may be employed, such as directional arrows or verbal cues, to coach a user back to an appropriate location relative to the subject 104.” EX1106, ¶0076.

L. Claim 19

236. Claim 19 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. [19.0] 19. A system comprising:

237. Kriveshko discloses a system. *See* [1.0] of this Ground.

2. [19.1] a handheld device and at least one display

238. Kriveshko discloses a handheld device and at least one display. *See* [1.1] and [1.4] of this Ground.

3. [19.2] wherein the handheld device is adapted for switching between performing at least one action in a physical 3D environment

239. The combination of Kriveshko and Serra discloses wherein the handheld device is adapted for switching between performing at least one action in a physical 3D environment. *See* [3.0] of this Ground. The at least one action is scanning and, as discussed, the combination of Kriveshko and Serra switches between scanning mode and interactive mode.

4. [19.3] wherein the at least one display is adapted for visually representing the physical 3D environment

240. Kriveshko discloses wherein the at least one display is adapted for visually representing the physical 3D environment. *See* [1.4] of this Ground.

5. [19.4] remotely controlling the display to adjust the view with which the 3D environment is represented on the display

241. The combination of Kriveshko and Serra discloses remotely controlling the display to adjust the view with which the 3D environment is represented on the display. *See* [1.5] of this Ground.

6. **[19.5] wherein the handheld device is an intra-oral 3D scanner and the at least one action performed in the physical 3D environment is scanning and that the view is remotely controlled by at least one motion sensor arranged in the handheld device**

242. The combination of Kriveshko and Serra discloses wherein the handheld device is an intra-oral 3D scanner and the at least one action performed in the physical 3D environment is scanning and that the view is remotely controlled by at least one motion sensor arranged in the handheld device. *See* [11.0], [3.0], [1.5], and [1.6] of this Ground.

7. **[19.6] wherein an actuator provided on the handheld device switches between performing the at least one action and remotely controlling the view**

243. The combination of Kriveshko and Serra discloses wherein an actuator provided on the handheld device switches between performing the at least one action and remotely controlling the view. As discussed in [3.0] of this Ground, the combination of Kriveshko and Serra switches between scanning mode and interactive mode based on actuation of a “button switch”.

8. **[19.7] wherein the at least one motion sensor is a sensor that directly detects motion**

244. The combination Kriveshko, Serra, and Hopkins discloses wherein the at least one motion sensor is a sensor that directly detects motion. *See* [1.6] and [1.7] of this Ground.

M. Claim 20

245. Claim 20 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[20.0] 20. The scanning system according to claim 1, wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer.**

246. The combination of Kriveshko, Serra, and Hopkins discloses wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer. *See* [1.6] and [1.7] of this Ground. It would have been obvious to use the accelerometer of Hopkins as the 3D sensor of the combination of Kriveshko and Serra.

N. Claim 21

247. Claim 21 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[21.0] 21. The scanning system according to claim 1, wherein the at least one motion sensor is adapted for taking the movement of the scanner into account while performing the scanning.**

248. The combination of Kriveshko and Serra discloses wherein the at least one motion sensor is adapted for taking the movement of the scanner into account while performing the scanning. Serra discloses, “a system [that] can record for each

acquired real-time image its 3D time and position. Therefore, in such exemplary embodiments, not only can a current image slice be displayed in its correct 3D position, but because the time of acquisition is available for each image, such methods also allow for the display of any previously acquired information at the given position.” EX1107, ¶0036. A POSA would consider recording the 3D time and position of acquisition of an image to be taking the movement of the scanner into account while performing the scanning.

249. In my opinion, a POSA would have been motivated to modify the scanning mode of the combination of Kriveshko, Serra, and Hopkins for the reasons discussed [1.5]-[1.7] of this Ground; and additionally to “allow[] for the visualization of time-variant processes” *Id.* Serra further describes that “a user can manage the entire 3D space within which ultrasound scans from a particular scanning session are obtained in a way that leads to better diagnosis and/or intervention.” *Id.*, ¶0037. Therefore, it would have been obvious to have at least one motion sensor adapted for taking the movement of the scanner into account while performing the scanning in the combination of Kriveshko, Serra, and Hopkins.

O. Claim 23

250. Claim 23 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[23.0] 23. The scanning system according to claim 1, wherein the at least one motion sensor is the 3D user**

interface for remotely controlling the display, wherein the view on the display is determined by moving the handheld scanner.

251. The combination of Kriveshko and Serra discloses wherein the at least one motion sensor is the 3D user interface for remotely controlling the display, wherein the view on the display is determined by moving the handheld scanner. As discussed in [1.5]-[1.7] of this Ground the combination of Kriveshko and Serra discloses that the view on the display is determined from motion sensor data generated while the handheld scanner is moved. Serra discloses that, “[b]ecause a user is generally always holding the ultrasound (or other substantially real-time image acquisition) probe, it is ergonomically convenient to allow him to control display parameters by actuating one or more buttons on the probe. For example, a button can be used to indicate when to use the probe to scan real-time or when to use it to rotate the entire virtual scene, which is a common a 3D data set interactive visualization operation.” *Id.*, ¶0053. Serra further discloses, “[t]hen, the user can release the button on the probe, and use the tracking information in the ultrasound probe to rotate the entire scene (effectively changing the viewpoint of the user over the entire 3D scene).” *Id.*, ¶0054.

252. Because the scanning device of the combination of Kriveshko, Serra, and Hopkins is remote from the display as discussed in claim 1 of this Ground and

because the 3D sensor is attached to the scanning device, the 3D sensor remotely controls the display.

253. Both Kriveshko (*see, e.g.*, EX1106, ¶0060), and Serra (*see, e.g.*, EX1107, ¶0045), disclose displays. A POSA reading the disclosure of Serra would understand a “virtual scene” to be a scene displayed on a display. *Id.*, ¶0053.

254. Thus, for the reasons discussed in [1.5]-[1.7] of this Ground it would have been obvious to determine the view of the display by moving the handheld scanner.

P. Claim 24

255. Claim 24 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[24.0] 24. The scanning system according to claim 23, wherein moving the handheld scanner to point down causes the view on the display to be a downward viewing angle.**

256. The combination of Kriveshko and Serra discloses wherein moving the handheld scanner to point down causes the view on the display to be a downward viewing angle. As discussed in [9.0] and [23.0] of this Ground, the virtual scene of the combination is rotated when the probe is moved in an interactive mode.

257. It would have been obvious to one of ordinary skill in the art at the time of the invention to implement controls in the manner claimed.

Q. Claim 25

258. Claim 25 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[25.0] 25. The scanning system according to claim 1, wherein the handheld device further comprises a user-interface element.**

259. Kriveshko discloses wherein the handheld device further comprises a user-interface element. Kriveshko discloses, “the scanner 102 is a handheld, freely positionable probe having at least one user input device, such as a button, lever, dial, thumb wheel, switch, or the like, for user control of the image capture system 100 such as starting and stopping scans.” EX1106, ¶0052. A POSA understands buttons, levers, dials, thumb wheels, and switches to be user interface elements.

R. Claim 26

260. Claim 26 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[26.0] 26. The scanning system according to claim 25, wherein the user-interface element comprises a touch-sensitive element, a button, a scroll-wheel, or a proximity sensor.**

261. Kriveshko discloses wherein the user-interface element comprises a touch-sensitive element, a button, a scroll-wheel, or a proximity sensor. Again, Kriveshko discloses, “the scanner 102 is a handheld, freely positionable probe having at least one user input device, such as a button, lever, dial, thumb wheel, switch, or the like, for user control of the image capture system 100 Such as starting

and stopping scans.” *Id.*, ¶0052. A POSA would understand a thumb wheel and a scroll-wheel to be the same thing.

S. Claim 27

262. Claim 27 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[27.0] 27. The scanning system according to claim 25, wherein the user-interface element provides more than one user input.**

263. Kriveshko discloses wherein the user-interface element provides more than one user input. And again, Kriveshko discloses, “the scanner 102 is a handheld, freely positionable probe having at least one user input device, such as a button, lever, dial, thumb wheel, switch, or the like, for user control of the image capture system 100 such as starting and stopping scans.” *Id.*, ¶0052. A POSA would starting and stopping scans to be different user inputs. Thus, Kriveshko provides more than one user input based on the disclosed “at least one user input device.”

T. Claim 28

264. Claim 28 is obvious over the combination of Kriveshko, Serra and Hopkins.

1. **[28.0] 28. The scanning system according to claim 25, wherein the at least one motion sensor and/or the user-interface element are utilized in a workflow.**

265. The combination of Kriveshko and Serra discloses wherein the at least one motion sensor and/or the user-interface element are utilized in a workflow.

Although not defined by the '221 patent, a POSA would understand a scanning procedure to be a “workflow.” Kriveshko discloses the following workflow: “In the recover mode, the system 100 may seek to reacquire the previous scan by test fitting new scan data to previously acquired data, and providing visual feedback to a user to assist in navigating back to a scan location on the subject where the re-acquisition is being attempted. In a related landing mode, a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model. Similar visual feedback tools may be provided to guide a user to an appropriate scan location, and notify a user when the scan has been reacquired.” EX1106, ¶0059.

266. Serra discloses, “ultrasound probes and instruments can, for example, be tracked by a 3D tracking system so that the each of the probes and instruments respective 3D positions and orientations can be known at all times during the ultrasound scan.” EX1106, ¶0042.

267. It would have been obvious to use the 3D tracking of Serra in the recover mode workflow of Kriveshko to improve Kriveshko’s ability to guide a user back to an appropriate location because of 3D tracking’s ability to allow a user to return to a recorded path location. A POSA would not have encountered any technological hurdles in using the motion sensor of Serra to improve the recovery mode workflow of Kriveshko.

U. Claim 31

268. Claim 31 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. [31.0] 31. The scanning system according to claim 1, wherein the at least one display is divided into multiple regions.

269. The combination of Kriveshko and Serra discloses wherein the at least one display is divided into multiple regions. Figure 4 illustrates a display divided into multiple regions.

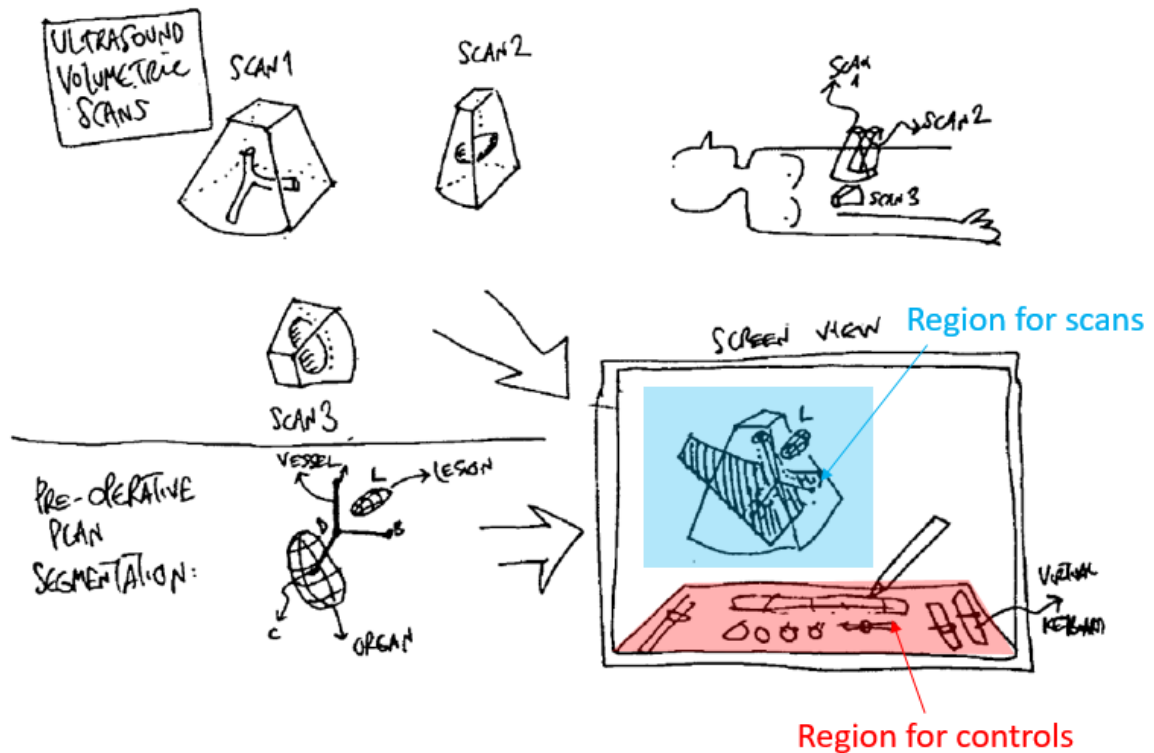


FIG. 4

EX1107, Fig. 4.

270. Serra discloses, “stored volumetric scans as well as the preoperative data...are objects that a clinician or other user can manipulate in the displayed 3D space to complete a diagnosis or guide an intervention.” *Id.*, ¶0051. For example, Figure 4. Serra further discloses, “a pen-and-tablet interface can be used for 2D control, as depicted in FIG. 1. With reference thereto, a user 100 can, for example, physically manipulate a pen 110 and table 120, and can thus interact with a virtual keyboard as shown at the bottom of display 130” *Id.*, ¶0044 (emphasis added); *see also id.*, ¶0035.

271. Thus, a POSA would have understood the combination of Kriveshko, Serra, and Hopkins to suggest that a display, such as the display of Serra, can be divided into multiple regions. Moreover, a POSA would have understood that having multiple viewports and windows on a single display was routine and conventional for interactive 3D graphics, and that the implementation of such was well within the ability of a POSA long before the priority date of the '221 patent.

V. Claim 32

272. Claim 32 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[32.0] 32. The system according to claim 19, wherein the handheld device further comprises a user interface element**

273. The combination of Kriveshko and Serra discloses wherein the handheld device further comprises a user interface element. *See* [1.5], [1.6], [3.0], [5.0], and [23.0] of this Ground. As discussed, the combination includes a “button switch” as a user interface element.

2. [32.1] wherein switching to remotely controlling the view puts the handheld device into a controller mode,

274. The combination of Kriveshko and Serra discloses wherein switching to remotely controlling the view puts the handheld device into a controller mode. *See* [1.5], [1.6], [3.0], [5.0], and [23.0] of this Ground. As discussed, Serra discloses, “an ultrasound hand-held probe can operate in two modes of interaction, one in scanning mode (with button switch ON, for example) as in most ultrasound scanners, and the other in interactive mode (with the button switch in the alternate position, here OFF). The user can scan the patient by pressing the ON button on the ultrasound probe and moving the probe over the region of interest. Then, the user can release the button on the probe, and use the tracking information in the ultrasound probe to rotate the entire scene (effectively changing the viewpoint of the user over the entire 3D scene).” EX1107, Serra, ¶0054.

275. A POSA would understand the described “interactive mode” to correspond to the claimed “controller mode” because the user can use the probe to rotate the entire scene in the interactive mode.

3. [32.2] wherein holding the user interface element and/or the actuator on the handheld device in conjunction with moving the handheld device determines the view of the 3D environment on the display in accordance with signals from the motion sensor.

276. The combination of Kriveshko and Serra discloses wherein holding the user interface element and/or the actuator on the handheld device in conjunction with moving the handheld device determines the view of the 3D environment on the display in accordance with signals from the motion sensor. *See* [1.5], [1.6], [3.0], [5.0], and [23.0] of this Ground.

277. As discussed above, Serra discloses, “the user can scan the patient by pressing the ON button on the ultrasound probe and moving the probe over the region of interest. Then, the user can release the button on the probe, and use the tracking information in the ultrasound probe to rotate the entire scene.” *Id.*, ¶0054. From this disclosure, a POSA would understand that the “ON button” is to be held to keep the probe a in the scanning mode because it teaches that when released the tracking information can be used to rotate the entire virtual scene. The scanner holds the device in a not pressed state to allow for the determination of view.

278. It would have been obvious to include such a feature in the combination for the reasons discussed in [1.5]-[1.7], [3.0], [5.0], and [23.0] of this Ground.

W. Claim 33

279. Claim 33 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[33.0] 33. A scanning system for scanning a 3D environment, the scanning system comprising:**

280. Kriveshko discloses a scanning system for scanning a 3D environment.

See [1.0] of this Ground.

2. **[33.1] a handheld device including an optical scanner**

281. Kriveshko discloses a handheld device including an optical scanner.

See [1.1] of this Ground.

3. **[33.2] wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment**

282. Kriveshko discloses wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment. *See* [1.2] of this Ground.

4. **[33.3] at least one display remotely connected to the handheld device**

283. Kriveshko discloses at least one display remotely connected to the handheld device. *See* [1.4] and [1.5] of this Ground. A POSA would understand that the scanner 102 of Kriveshko is remotely connected to the display of the computer 108. “Communications between the computer 108 and the scanner 102 may use any suitable communications link including, for example, a wired connection or a wireless connection based upon, for example, IEEE 802.11 (also known as wireless

Ethernet), BlueTooth, or any other suitable wireless standard using, e.g., a radio frequency, infrared, or other wireless communication medium.” EX1106, Kriveshko, ¶0057.

5. [33.4] wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment

284. Kriveshko discloses wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment. *See* [1.3] of this Ground.

6. [33.5] the at least one display is adapted for visually representing the physical 3D environment

285. Kriveshko discloses the at least one display is adapted for visually representing the physical 3D environment. *See* [1.4] of this Ground.

7. [33.6] wherein the handheld device includes at least one motion sensor for remotely controlling the display to adjust the view with which the 3D environment is represented on the display

286. The combination of Kriveshko and Serra discloses wherein the handheld device includes at least one motion sensor for remotely controlling the display to adjust the view with which the 3D environment is represented on the display. *See* [1.5] and [1.6] of this Ground.

8. [33.7] wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer.

287. The combination of Kriveshko, Serra, and Hopkins discloses wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer. *See* [1.5]-[1.7] of this Ground.

X. Claim 34

288. Claim 34 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. [34.0] 34. The scanning system according to claim 33, wherein the handheld device further comprises at least two user interface elements.

289. Kriveshko discloses wherein the handheld device further comprises at least two user interface elements. Kriveshko discloses, “[i]n one embodiment, the scanner 102 is a handheld, freely positionable probe having at least one user input device. Such as a button, lever, dial, thumb wheel, switch, or the like, for user control of the image capture system 100 Such as starting and stopping scans.” EX1106, Kriveshko, ¶0052. Figure 1 depicts a scanner 102 with 4 buttons. Thus, a POSA would understand Kriveshko’s Figure 1 to disclose a handheld device with at least two user interface elements (buttons).

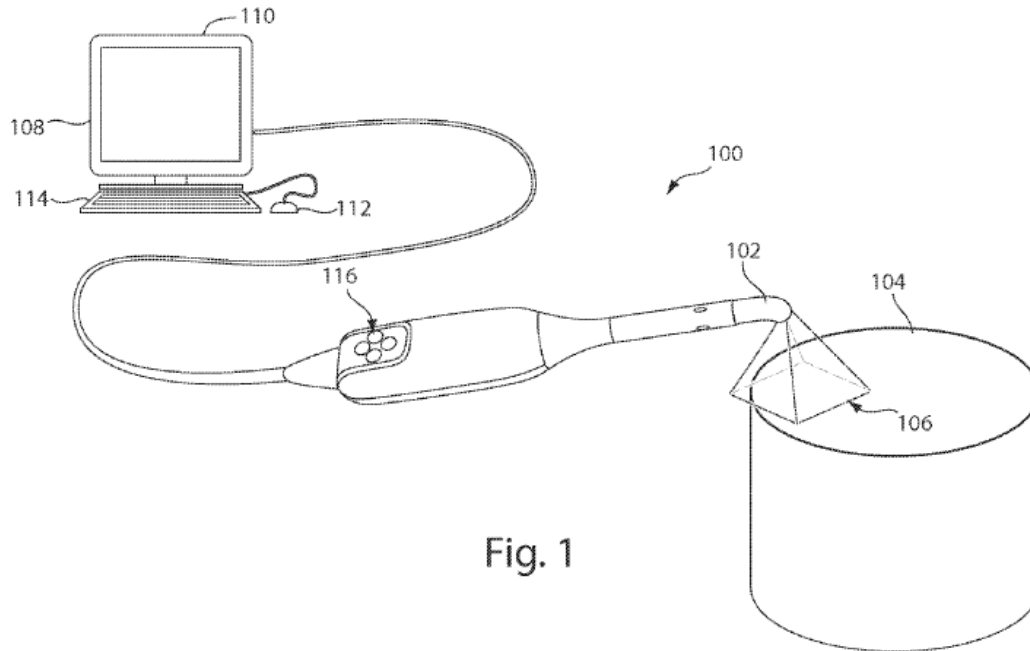


Fig. 1

Id., Fig. 1.

Y. Claim 40

290. Claim 40 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. [40.0] 40. The scanning system according to claim 1, wherein the at least one display is a 3D display

291. The combination of Kriveshko and Serra discloses wherein the at least one display is a 3D display. Serra explains that, “[i]n exemplary embodiments according to the present invention, two options can be used to integrate systems implementing an exemplary embodiment of the present invention.” EX1107, Serra, ¶¶0070, 0073-74. (describing a “Full Integration Option” and an “External Box Option”). In the full integration option, Serra describes use of a stereoscopic or

autostereoscopic display. “Optionally, any Stereoscopic display technique can be used, such as autostereoscopic displays” EX1107, Serra, ¶0074. A POSA would understand displays implementing stereoscopic techniques and autostereoscopic displays to be 3D displays. I address obviousness in [40.2], below.

2. [40.1] whereby a 3D representation of the 3D environment is displayed on the 3D display

292. The combination of Kriveshko and Serra discloses whereby a 3D representation of the 3D environment is displayed on the 3D display. Serra further discloses, “FIGS. 9(a) through (i) illustrate a few of the various possibilities available to a user in exemplary embodiments of the present invention. Pre-operative segmentations and virtual objects, or even 2D and/or 3D ultrasound images form moments before, can, in such exemplary embodiments, be fused with live ultrasound data due.” *Id.*, ¶0087. The numerous 3D representations are disclosed by Serra. *Id.*, ¶¶0087, 0078-92. Serra discloses creating 3D data from the scans, and explains how this data can be presented in stereo, how stereo assists the user, and about using stereoscopic displays along with other displays for displaying stereoscopic data; noting, “any Stereoscopic display technique can be used, Such as autostereoscopic displays, or anaglyphic red-green display techniques, using known techniques.” EX1107, Serra, ¶0074. While Serra does not explicitly disclose that any of these representations are displayed on a 3D display of Serra, a POSA reading the disclosure of Serra understands the 3D images of Serra are to be displayed on the

3D display of Serra. In any case, it would have been obvious to display the 3D images of Serra on a 3D display.

3. [40.2] wherein the handheld device is an intra-oral 3D scanner or an in-ear 3D scanner.

293. The combination of Kriveshko and Serra discloses wherein the handheld device is an intra-oral 3D scanner or an in-ear 3D scanner. As discussed in [11.0] of this Ground, Kriveshko discloses an intra oral scanner.

294. Kriveshko further disclose a display 110 and displaying 3D renderings on the display: “For example, in the normal acquisition mode, the display 110 may show a video image of the subject 104, as viewed from the scanner 102. The computer may render the three-dimensional model, which may be a three-dimensional point cloud of surface data acquired for the subject 104, superimposed on the video image.” EX1106, Kriveshko, ¶0076.

295. As discussed in [40.0] and [40.1] above, Serra is also directed to display 3D images. Serra further discloses, “the system and methods of the present invention can apply to any substantially real-time image acquisition system, not being restricted to ultrasound.” EX1107, Serra, ¶0093.

296. At the time of the invention it would have been obvious to modify Kriveshko to display its 3D renderings on a 3D display such as the 3D displays disclosed by Serra. A POSA would have been motivated to do so in the natural

course of development based on the known ability to display images on 3D displays and following the teachings of Serra.

Z. Claim 41

297. Claim 41 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[41.0] 41. The scanning system according to claim 40, wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation.**

298. The combination of Kriveshko and Serra discloses wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation. As discussed in [40.0] above, Serra discloses stereoscopic and autostereoscopic displays, stating “any stereoscopic display technique can be used, such as autostereoscopic displays, or anaglyphic red-green display techniques, using known techniques.” EX1107, Serra, ¶0074. A POSA understands that a stereoscopic display necessarily displays stereoscopic image pairs.

299. Thus, it would have been obvious to a POSA at the time of the invention for the combination of Kriveshko, Serra, and Hopkins to use the 3D display to project stereoscopic image pairs of the 3D representation for the reasons discussed in [40.2] of this Ground.

AA. Claim 42

300. Claim 42 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[42.0] 42. The scanning system according to claim 40, wherein the 3D display is volumetric display configured to create a 3D effect of the 3D representation.**

301. The combination of Kriveshko and Serra discloses wherein the 3D display is volumetric display configured to create a 3D effect of the 3D representation. Serra discloses the rendering of volumetric images: “In exemplary embodiments of the present invention a 3D interactive system is provided that can work with either ultrasound planes (shown in their respective 3D context), volumetric reconstructions of such ultrasound information.” A POSA understands that stereoscopic and autostereoscopic displays are volumetric displays. Thus, it would have been obvious to use 3D display is volumetric display configured to create a 3D effect of the 3D representation in the combination of Kriveshko, Serra, and Hopkins to for the reasons discussed in [40.2] of this Ground.

BB. Claim 43

302. Claim 43 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. **[43.0] 43. The system according to claim 19, wherein the at least one display is a 3D display**

303. The combination of Kriveshko and Serra discloses wherein the at least one display is a 3D display. *See* [40.0] of this Ground.

2. **[43.1] whereby a 3D representation of the 3D environment is displayed on the 3D display**

304. The combination of Kriveshko and Serra discloses whereby a 3D representation of the 3D environment is displayed on the 3D display. *See* [40.1] of this Ground.

3. [43.2] wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation

305. The combination of Kriveshko and Serra discloses wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation. *See* [40.2] and [41.1] of this Ground.

CC. Claim 44

306. Claim 44 is obvious over the combination of Kriveshko, Serra, and Hopkins.

1. [44.0] 44. The scanning system according to claim 33, wherein the at least one display is a 3D display

307. The combination of Kriveshko and Serra discloses wherein the at least one display is a 3D display. *See* [40.0] of this Ground.

2. [44.1] whereby a 3D representation of the 3D environment is displayed on the 3D display

308. The combination of Kriveshko and Serra discloses whereby a 3D representation of the 3D environment is displayed on the 3D display. *See* [40.1] of this Ground.

3. [44.2] wherein the handheld device is an intra-oral 3D scanner or an in-ear 3D scanner

309. The combination of Kriveshko and Serra discloses wherein the handheld device is an intra-oral 3D scanner or an in-ear 3D scanner. *See* [40.2] of this Ground.

4. [44.3] wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation

310. The combination of Kriveshko and Serra discloses wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation. *See* [41.0] of this Ground.

X. GROUND 3: CLAIM 22 IS OBVIOUS OVER KRIVESHKO, SERRA, HOPKINS, AND WILSON

A. Claim 22

311. Claim 22 is obvious over the combination of Kriveshko, Serra, Hopkins, and Wilson

1. [22.0] 22. The scanning system according to claim 1, wherein the system comprises at least two motion sensors and wherein the at least two motion sensors provide sensor fusion.

312. The combination of Kriveshko, Serra, Hopkins, and Wilson discloses wherein the system comprises at least two motions sensors and wherein the at least two motion sensors provide sensor fusion. The '221 patent does not define “sensor fusion,” but generally, sensor fusion is the combining of sensor outputs from different sensor groups or modalities into a single measurement, which is an improved measurement in accuracy, noise, lag, drift, speed or combination utilizing

the qualities of each sensor for overall improved tracking performance. For example, if both electromagnetic sensors and optical sensors are used to determine the position and orientation of a medical instrument then a correlated set of position and orientation values from the electromagnetic sensors and the optical sensors would be fused by using a model to produce a single set of values that describe the position and orientation of the medical instrument.

313. The limitations of claim 1 are met by the combination of Kriveshko, Serra, and Hopkins for the reasons discussed in Ground 2. As discussed, Serra discloses “an ultrasound probe with a 3D tracker.” EX1107, Serra, ¶0049. Recall that Serra discloses, “the 3D position of the ultrasound probe 715 can be tracked by 3D tracker 703, by, for example, 3D sensor 720 which is attached to ultrasound probe 715.” *Id.*, ¶0074. It would have been obvious to a POSA to use multiple motion sensors and sensor fusion in the system of the combination of Kriveshko, Serra, and Hopkins based on the teachings of Wilson.

314. Wilson discloses a handheld wand for performing gestures and pointing to determine device to be control and the control action to be performed. EX1010, Abstract. Wilson explains that in an operating room implementation, “the medical person 1306 uses the wireless remote control user interface (UI) device 1404 (hereinafter referred to as a “wand”) to facilitate control of the operation computer system 1308.” *Id.*, ¶0145.

315. Wilson explains that, “the orientation sensors of the wand 1404 include at least, an accelerometer, which provides separate x-axis and y-axis orientation signals, and a magnetometer, which provides separate tri-axial measurements (x-axis, y-axis, and z-axis) orientation signals.” *Id.*, ¶0146. Wilson further explains that “[t]he orientation of the pointer is defined in terms of its pitch, roll and yaw angle about the respective x, y and z axes of the environment's pre-defined coordinate system. These angles can be determined via various sensor fusion processing schemes that essentially compute the angle from the readings from the accelerometer and magnetometer of the pointer.” *Id.*, ¶0151 (emphasis added).

316. One of ordinary skill in the art would recognized the benefits of using a combination of the accelerometer of the combination of Kriveshko, Serra, and Hopkins and a second motion sensing device such as the magnetometer of Wilson. These benefits include, for example, the ability to eliminate sensor drift cause by accelerometer calculations. EX1023, Ferreira, at “3D Information Integration” (“Another sensor which can be included to reset the accumulated drift in the attitude computation is the 3D magnetic compass, since a good source for absolute orientation of a mobile system is the earth’s magnetic field.”).

317. Therefore, in my opinion, it would have been obvious to a POSA to combine Kriveshko, Serra, and Hopkins with Wilson to arrive at the limitations of claim 22.

XI. GROUND 4: CLAIM 30 IS OBVIOUS OVER KRIVESHKO, SERRA, HOPKINS, AND QUAID

A. Claim 30

318. Claim 30 is obvious over the combination of Kriveshko, Serra, Hopkins, and Quaid.

1. [30.0] 30. The scanning system according to claim 1, wherein the at least one display is arranged on a cart.

319. The previously addressed combination of Kriveshko, Serra, and Hopkins does not disclose wherein the at least one display is arranged on a cart. However, the use of carts to support the mobility and accessibility of medical devices was well-known and would have been obvious. For example, Quaid discloses, “the display device 23 may be disposed on or near the computer 21 (e.g., on the cart 29 as shown in FIG. 1) or may be remote from the computer 21 (e.g., mounted on a wall of an operating room or other location suitable for viewing by the user). The display device 23 is preferably adjustable so that the user can position/reposition the display device 23 as needed during a surgical procedure. For example, the display device 23 may be disposed on an adjustable arm (not shown) that is connected to the cart 29[.]”

EX1111, ¶0093. Figure 1 of Quaid is reproduced below:

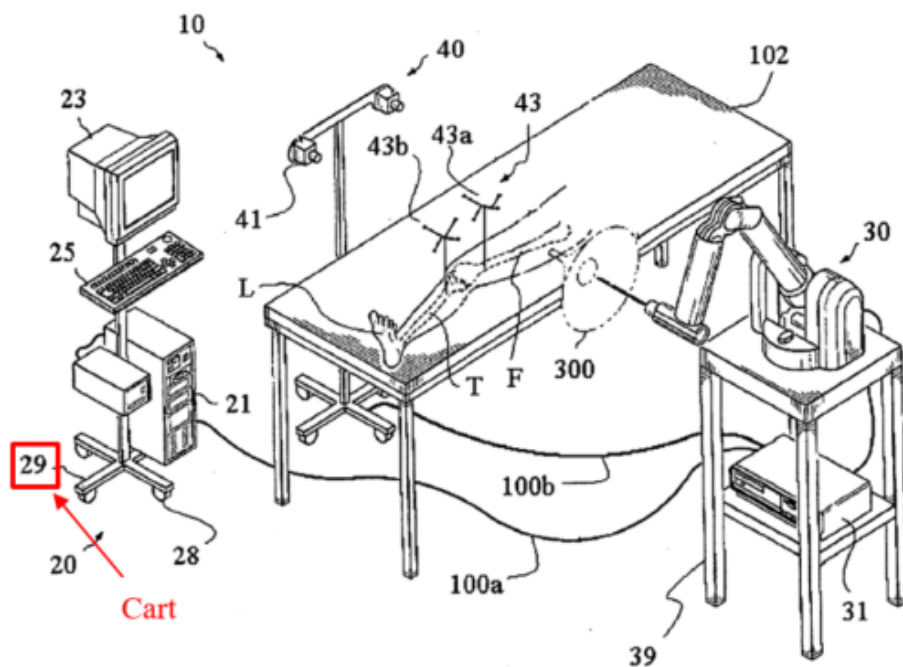


FIG. 1

320. Quaid explains the benefits of carts for medical devices at length: “The cart 29 may be, for example, a known cart, platform, or equipment stand and is preferably configured for ease of mobility of the computing system 20. For example, as shown in FIG. 1, the cart 29 may include rolling members 28 (e.g., wheels or casters) to enable the cart 29 to be moved. The cart 29 may also include a mechanism for securing the cart 29 in position. For example, the cart 29 may be equipped with wheel locks or brakes for the rolling members 28, a foot pedal locking device, jack stands, and/or any other known mechanism for securing a cart in position. In this manner, the cart 29 enables the computing system 20 to be moved from one location

to another, positioned as necessary for each surgical case, and secured in a desired position during storage and surgery.” EX1111, ¶0096.

321. Thus, in my opinion, the reasons discussed by Quaid, it would have been obvious to place at least one monitor of the combination of Kriveshko, Serra, and Hopkins on a cart. A POSA would have a reasonable expectation of successfully arranging a display on a cart if desired.

XII. GROUND 5: CLAIMS 1-3, 5-7, 9-11, 15, 19-21, 21-28, 31-34, AND 40-44 ARE OBVIOUS OVER KRIVESHKO, SERRA, AND MARVIT

A. Claim 1

322. Claim 1 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. [1.0] A scanning system for scanning a 3D environment, the scanning system comprising:

323. Kirveshko discloses a scanning system for scanning a 3D environment, the scanning system. *See* [1.0] of Ground 2.

2. [1.1] a handheld device including an optical scanner

324. Kriveshko discloses a handheld device including an optical scanner. *See* [1.1] of the Ground 2.

3. [1.2] wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment

325. Kriveshko discloses wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment. *See* [1.2] of Ground 2.

4. [1.3] wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment

326. Kriveshko discloses wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment. *See* [1.3] of Ground 2.

5. [1.4] the at least one display is adapted for visually representing the physical 3D environment

327. Kriveshko discloses the at least one display is adapted for visually representing the physical 3D environment. *See* [1.4] of Ground 2.

6. [1.5] the handheld device includes a 3D user interface for remotely controlling the display to adjust the view with which the 3D environment is represented on the display

328. The combination of Kriveshko and Serra discloses the handheld device includes a 3D user interface for remotely controlling the display to adjust the view with which the 3D environment is represented on the display. *See* [1.5] of Ground 2.

7. [1.6] wherein the handheld device comprises at least one motion sensor

329. The combination of Kriveshko and Serra discloses wherein the handheld device comprises at least one motion sensor. *See* [1.6] of Ground 2.

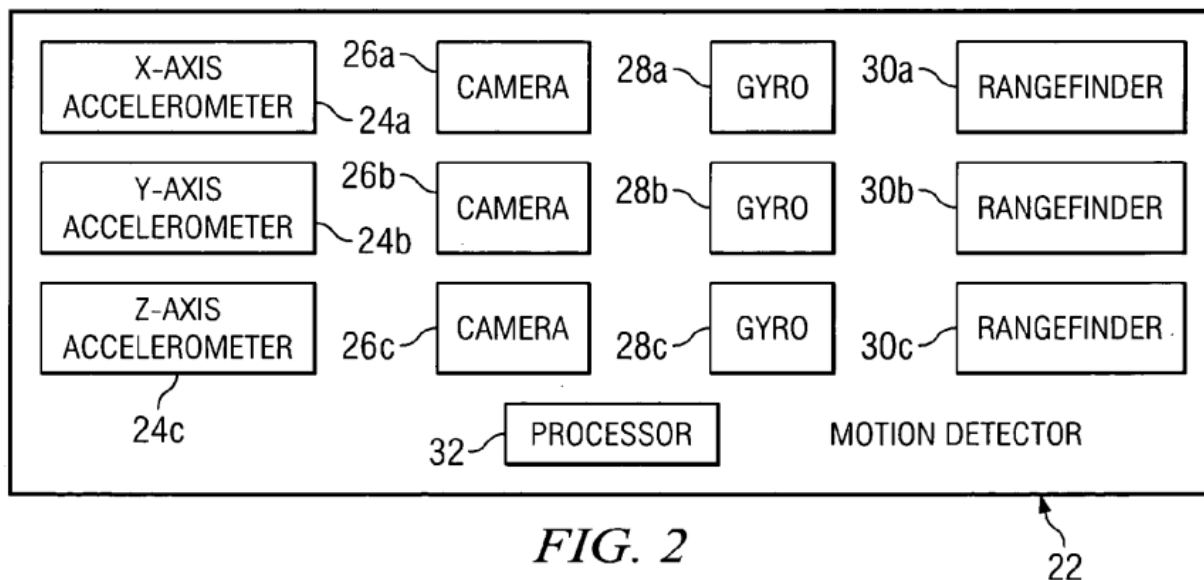
8. [1.7] wherein the at least one motion sensor is a sensor that directly detects motion

330. The combination of Kriveshko, Serra, and Marvit discloses wherein the at least one motion sensor is a sensor that directly detects motion. As discussed in [1.7] of Ground 2, in my opinion, the combination of Kriveshko and Serra alone discloses a sensor that directly detects motion. To the extent it is argued that it does not, Marvit discloses a motion sensor that directly detects motion and it would have been obvious to combine its teachings with the combination of Kriveshko and Serra to meet this limitation of claim 1.

331. Serra discloses, “an ultrasound probe with a 3D tracker.” EX1107, Serra, ¶0049. Serra further discloses “the 3D position of the ultrasound probe 715 can be tracked by 3D tracker 703, by, for example, 3D sensor 720 which is attached to ultrasound probe 715.” *Id.*, ¶0074.

332. Marvit discloses handheld device 10 that, “can recognize movement of the device and can perform various functions corresponding to such movement,” and that includes “a display 12, input 14, processor 16, memory 18, communications interface 20 and motion detector 22.” EX1109, ¶¶0034-35. Marvit explains that the “motion detector 22 includes accelerometers 24 a, 24 b and 24 c; cameras 26 a, 26 b and 26 c; gyros 28 a, 28 b and 28 c; rangefinders 30 a, 30 b and 30 c; and a processor 32.” *Id.* ¶¶0038-0044, 0051, 0052, 0055-0057, Figs. 2, 4. Marvit discloses rotation

and translation data from the motion detector can “serve as an input from a user to operate the device.” *Id.*



Id., Fig. 2

333. A POSA would have been motivated to use the accelerometers or gyros of Marvit as the 3D sensor of Serra to recognize translation, rotation, and/or gesture inputs (*e.g.*, position and orientation data) from the motion of the scanner of the combination of Kriveshko and Serra. The combination of Kriveshko and Serra considers “each of the probes’ and instruments’ respective 3D positions and orientations . . . at all times during the ultrasound scan.” EX1107, ¶0042. Kriveshko, Serra, and Marvit are analogous art and describe handheld electronic devices that employ user input techniques and gesture-based input functionality for controlling or manipulating an image on a display that were well-known by at least 2007.

EX1105, ¶¶4, 12, 37, 50-54, Figs. 7-8, 10; EX1006, ¶¶35, 38-44, 51-52, 55-57, Figs. 2, 4.

334. A POSA would have incorporated Marvit's accelerometer or gyro into Serra-Kriveshko's 3D sensor with a reasonable expectation of success because the principles of operation for both systems were well-understood and predictable, such that it would have been straight-forward to incorporate an accelerometer or gyro of Marvit into Serra-Kriveshko's 3D sensor, using routine steps to produce a 3D sensor having an accelerometer or gyro to measure position and orientation data of a scanner.

335. Incorporation of an accelerometer or a gyro into a handheld device for detecting position or orientation data of the handheld device in order to manipulate a display was conventional within the medical field, motion detection, as well as smart devices by the earliest possible priority date. *See, e.g.*, EX1023, Ferreira, Abstract, "3D Information Integration," "System Architecture." Indeed, MEMS accelerometers were developed as early as the 1980s, and a compact accelerometer/gyro chip could be implemented in a variety of devices, which is explicitly demonstrated by Marvit itself. *See, e.g.*, EX1032; EX1033; EX1006.

B. Claim 2

336. Claim 2 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[2.0] 2. The scanning system according to claim 1, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.**

337. Kriveshko discloses wherein the handheld device is adapted to record the 3D geometry of the 3D environment. *See* [2.0] of Ground 2.

C. Claim 3

338. Claim 3 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[3.0] 3. The scanning system according to claim 1, wherein the handheld device includes an actuator for manually switching between performing the at least one scanning action and remotely controlling the view.**

339. The combination of Kriveshko and Serra discloses wherein the handheld device includes an actuator for manually switching between performing the at least one scanning action and remotely controlling the view. *See* [3.0] of Ground 2.

D. Claim 5

340. Claim 5 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[5.0] 5. The scanning system according to claim 1, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor.**

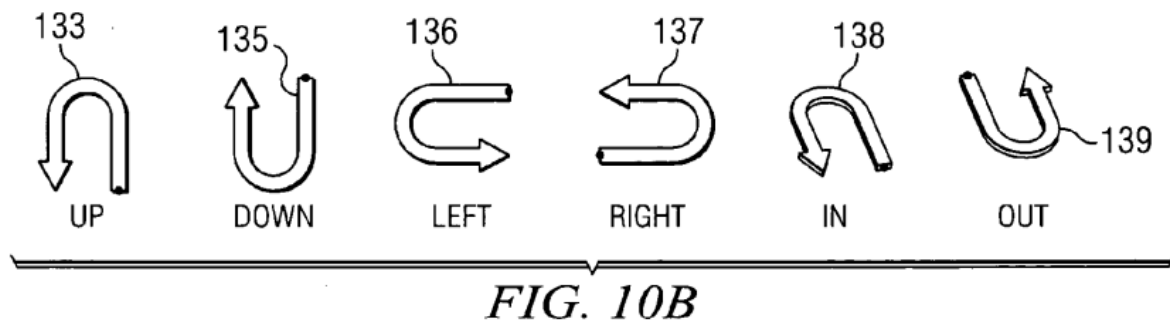
341. The combination of Kriveshko and Serra discloses wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor. *See* [5.0] of Ground 2.

E. Claim 6

342. Claim 6 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. [6.0] 6. The scanning system according to claim 1, wherein functionality of the 3D user interface comprises a use of gestures.

343. The combination of Kriveshko, Serra, and Marvit discloses wherein functionality of the 3D user interface comprises a use of gestures. Marvit discloses “a motion controlled handheld device includes a display having a viewable surface and operable to generate a current image.” Marvit discloses the use of gesture to control a display and explains, for example, “FIG. 10B illustrates example gestures which may be utilized to perform various functions, such as functions enabling a user to navigate through a virtual desktop. The illustrated example of gestures include an ‘up’ gesture 133 to navigate in an upward direction through the desktop, a ‘down’ gesture 135 to navigate down, a ‘left’ gesture 136 to navigate left, a ‘right’ gesture 137 to navigate right, an ‘in’ gesture 138 to navigate in a direction towards the user and an ‘out’ gesture 139 to navigate away from the user.” EX1109, ¶0083.



Id., Fig. 10B. Marvit describes numerous functionality that can be implemented through gestures. EX1109, ¶¶0040, 0066, 0074-82, 102-104, 134-39.

344. One of ordinary skill in the art would have been motivated to include the use of gestures in the 3D interface of the combination of Kriveshko, Serra, and Marvit to increase the functionality of the combination. A POSA would recognize that gestures further Serra’s goal of creating an “efficient and ergonomic interface that can allow a user to easily interact with ultrasound scan data as well as preoperative imaging and planning data in three dimensions.” EX1107, ¶¶0011. For example, one of ordinary skill in the art would recognize that with the addition of gesture control the combination would be better able to navigate application interfaces in addition to manipulating 3D data. EX1109, ¶¶0040, 0066, 0074-82, 102-104, 134-39.

345. Thus, it would have been obvious to incorporate gestures into the 3D interface of the combination of Kriveshko and Serra using the teachings of Marvit.

F. Claim 7

346. Claim 7 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[7.0] 7. The scanning system according to claim 6, wherein the gestures are detected by the at least one motion sensor.**

347. The combination of Kriveshko, Serra, and Marvit discloses wherein the gestures are detected by the at least one motion sensor. *See* [6.0] of this Ground. As discussed, it would have been obvious to modify Kriveshko and Serra to implement gestures according Marvit, with such gestures being detected by the motion sensor(s) of Kriveshko and Serra for the reasons discussed in [6.0] of this Ground.

G. Claim 9

348. Claim 9 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[9.0] 9. The scanning system according to claim 1, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.**

349. The combination of Kriveshko and Serra discloses wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display. *See* [9.0] of Ground 2.

H. Claim 10

350. Claim 10 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[10.0] 10. The scanning system according to claim 1, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.**

351. The combination of Kriveshko and Serra discloses wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display. *See* [10.0] of Ground 2.

I. Claim 11

352. Claim 11 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[11.0] 11. The scanning system according to claim 1, wherein the handheld device is an intra-oral 3D scanner.**

353. Kriveshko discloses wherein the handheld device is an intra-oral 3D scanner. *See* [11.0] of Ground 2.

J. Claim 15

354. Claim 15 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[15.0] 15. The scanning system according to claim 1, wherein the at least one display is defined as a first display**

355. The combination of Kriveshko and Serra discloses wherein the at least one display is defined as a first display. *See* [15.0] and [15.1] of Ground 2.

2. **[15.1] where the system further comprises a second display**

356. The combination of Kriveshko and Serra discloses where the system further comprises a second display. *See* [15.1] of Ground 2.

K. Claim 19

357. Claim 19 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. [19.0] 19. A system comprising:

358. Kriveshko discloses a system. *See* [1.0] of Ground 2.

2. [19.1] a handheld device and at least one display

359. Kriveshko discloses a handheld device and at least one display. *See* [1.1] and [1.4] of Ground 2.

3. [19.2] wherein the handheld device is adapted for switching between performing at least one action in a physical 3D environment

360. Kriveshko and Serra discloses wherein the handheld device is adapted for switching between performing at least one action in a physical 3D environment. *See* [3.0] of Ground 2. The at least one action is scanning and, as discussed, the combination of Kriveshko and Serra switches between scanning mode and interactive mode.

4. [19.3] wherein the at least one display is adapted for visually representing the physical 3D environment

361. Kriveshko discloses remotely controlling the display to adjust the view with which the 3D environment is represented on the display. *See* [1.4] of Ground 2.

5. [19.4] remotely controlling the display to adjust the view with which the 3D environment is represented on the display

362. The combination of Kriveshko and Serra discloses remotely controlling the display to adjust the view with which the 3D environment is represented on the display. *See* [1.5] of Ground 2.

6. [19.5] wherein the handheld device is an intra-oral 3D scanner and the at least one action performed in the physical 3D environment is scanning and that the view is remotely controlled by at least one motion sensor arranged in the handheld device

363. The combination of Kriveshko and Serra discloses wherein the handheld device is an intra-oral 3D scanner and the at least one action performed in the physical 3D environment is scanning and that the view is remotely controlled by at least one motion sensor arranged in the handheld device. *See* [11.0], [3.0], [1.5], and [1.6] of Ground 2.

7. [19.6] wherein an actuator provided on the handheld device switches between performing the at least one action and remotely controlling the view

364. The combination of Kriveshko and Serra discloses wherein an actuator provided on the handheld device switches between performing the at least one action and remotely controlling the view.

365. As discussed in [3.0] of Ground 2, the combination of Kriveshko and Serra switches between scanning mode and interactive mode based on actuation of a “button switch”.

8. [19.7] wherein the at least one motion sensor is a sensor that directly detects motion

366. The combination of Kriveshko, Serra, and Marvit discloses wherein the at least one motion sensor is a sensor that directly detects motion as discussed in [1.7] of this Ground.

L. Claim 20

367. Claim 20 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. [20.0] 20. The scanning system according to claim 1, wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer.

368. The combination of Kriveshko, Serra, and Marvit discloses wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer for the reasons it would have been obvious to incorporate the accelerometer of Marvit as the sensor that directly detects motion. *See* [1.7], [19.6] and [19.7] of this Ground.

M. Claim 21

369. Claim 21 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. [21.0] 21. The scanning system according to claim 1, wherein the at least one motion sensor is adapted for

taking the movement of the scanner into account while performing the scanning.

370. The combination of Kriveshko and Serra discloses wherein the at least one motion sensor is adapted for taking the movement of the scanner into account while performing the scanning. See [21.0] of Ground 2.

N. Claim 22

371. Claim 22 is obvious over the combination of Kriveshko, Serra, and Marvit.

- 1. [22.0] 22. The scanning system according to claim 1, wherein the system comprises at least two motion sensors and wherein the at least two motion sensors provide sensor fusion.**

372. The combination of Kriveshko, Serra, and Marvit discloses wherein the system comprises at least two motion sensors and wherein the at least two motion sensors provide sensor fusion. Marvit discloses handheld device that uses a variety of sensors including accelerometers and gyros to implement use functions. EX1109, ¶¶0034-35, 0038-0044, 0051, 0052, 0055-0057, Figs. 2, 4. EX1003, ¶¶339-41. Marvit discloses, “[a]s described above, the raw motion data may be received by any combination of accelerometers, gyros, cameras, rangefinders or any other suitable motion detection components. At step 174, the raw motion data is processed to produce a motion detector output indicative of the motion of the device. Such processing may include various filtering techniques and fusion of data from multiple detection components.” EX1109, ¶107; *see also id.*, ¶161.

373. A POSA would have been motivated to use multiple sensors and have sensor fusion techniques to provide the position and orientation data in the combination of Kriveshko, Serra, and Marvit because it was well-known that such implementation provides more robust and accurate sensor data. Such sensors are inexpensive and have small device footprints. Further, sensor fusion techniques are well-known and have been implemented by others in similar handheld devices. A POSA would also have had a reasonable expectation of success when seeking to add additional sensors and sensor fusion logic to the combination of Kriveshko Serra and Marvit.

374. It is my opinion that it would have been obvious to detect motion in the combination of Kriveshko, Serra, and Marvit using multiple sensors and sensor fusion techniques.

O. Claim 23

375. Claim 23 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[23.0] 23. The scanning system according to claim 1, wherein the at least one motion sensor is the 3D user interface for remotely controlling the display, wherein the view on the display is determined by moving the handheld scanner.**

376. The combination of Kriveshko and Serra discloses wherein the at least one motion sensor is the 3D user interface for remotely controlling the display,

wherein the view on the display is determined by moving the handheld scanner. *See* [23.0] of Ground 2.

P. Claim 24

377. Claim 24 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[24.0] 24. The scanning system according to claim 23, wherein moving the handheld scanner to point down causes the view on the display to be a downward viewing angle.**

378. The combination of Kriveshko and Serra discloses wherein moving the handheld scanner to point down causes the view on the display to be a downward viewing angle. *See* [24.0] of Ground 2.

Q. Claim 25

379. Claim 25 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[25.0] 25. The scanning system according to claim 1, wherein the handheld device further comprises a user-interface element.**

380. Kriveshko discloses wherein the handheld device further comprises a user-interface element. *See* [25.0] of Ground 2.

R. Claim 26

381. Claim 26 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[26.0] 26. The scanning system according to claim 25, wherein the user-interface element comprises a touch-sensitive element, a button, a scroll-wheel, or a proximity sensor**

382. Kriveshko discloses wherein the user-interface element comprises a touch-sensitive element, a button, a scroll-wheel, or a proximity sensor. *See* [26.0] of Ground 2.

S. Claim 27

383. Claim 27 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[27.0] 27. The scanning system according to claim 25, wherein the user-interface element provides more than one user input.**

384. Kriveshko discloses wherein the user-interface element provides more than one user input. *See* [27.0] of Ground 2.

T. Claim 28

385. Claim 28 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[28.0] 28. The scanning system according to claim 25, wherein the at least one motion sensor and/or the user-interface element are utilized in a workflow.**

386. The combination of Kriveshko and Serra discloses wherein the at least one motion sensor and/or the user-interface element are utilized in a workflow. *See* [28.0] of Ground 2.

U. Claim 31

387. Claim 31 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[31.0] 31. The scanning system according to claim 1, wherein the at least one display is divided into multiple regions.**

388. The combination of Kriveshko and Serra discloses wherein the at least one display is divided into multiple regions. *See* [31.0] of Ground 2.

V. Claim 32

389. Claim 32 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[32.0] 32. The system according to claim 19, wherein the handheld device further comprises a user interface element**

390. The combination of Kriveshko and Serra discloses “wherein the handheld device further comprises a user interface element.” *See* [1.5], [1.6], [3.0], [5.0], and [23.0] of Ground 2. As discussed the combination includes a “button switch” as a user interface element.

2. **[32.1] wherein switching to remotely controlling the view puts the handheld device into a controller mode,**

391. The combination of Kriveshko and Serra discloses “wherein switching to remotely controlling the view puts the handheld device into a controller mode.” *See* [1.5], [1.6], [3.0], [5.0], and [23.0] of Ground 2. As discussed, Serra discloses

“an ultrasound hand-held probe can operate in two modes of interaction, one in scanning mode (with button switch ON, for example) as in most ultrasound scanners, and the other in interactive mode (with the button switch in the alternate position, here OFF). The user can scan the patient by pressing the ON button on the ultrasound probe and moving the probe over the region of interest. Then, the user can release the button on the probe, and use the tracking information in the ultrasound probe to rotate the entire scene (effectively changing the viewpoint of the user over the entire 3D scene).” EX1107, Serra, ¶0054.

392. A POSA would understand the described “interactive mode” to correspond to the claimed “controller mode” because the user can use the probe to rotate the entire scene in the interactive mode.

3. [32.2] wherein holding the user interface element and/or the actuator on the handheld device in conjunction with moving the handheld device determines the view of the 3D environment on the display in accordance with signals from the motion sensor.

393. The combination of Kriveshko and Serra discloses wherein holding the user interface element and/or the actuator on the handheld device in conjunction with moving the handheld device determines the view of the 3D environment on the display in accordance with signals from the motion sensor. *See* [1.5], [1.6], [3.0], [5.0], and [23.0] of Ground 2.

394. As discussed above Serra discloses, “the user can scan the patient by pressing the ON button on the ultrasound probe and moving the probe over the region of interest. Then, the user can release the button on the probe, and use the tracking information in the ultrasound probe to rotate the entire scene.” *Id.*, ¶0054. From this disclosure, a POSA would understand that the “ON button” is to be held to keep the probe a in the scanning mode because it teaches that when released the tracking information can be used to rotate the entire virtual scene. POSA understands that for the 3D sensor of Serra to rotate the scene it sends signals to a computing device that alters the displayed scene. Thus, the displayed scene is displayed in accordance with signals from the motion sensor of Serra.

395. It would have been obvious to include such a feature in the combination for the reasons discussed in [1.5], [1.6], [3.0], [5.0], and [23.0] of Ground 2.

W. Claim 33

396. Claim 33 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. [33.0] 33. A scanning system for scanning a 3D environment, the scanning system comprising:

397. Kriveshko discloses a scanning system for scanning a 3D environment. *See* [1.0] of Ground 2.

2. [33.1] a handheld device including an optical scanner

398. Kriveshko discloses a handheld device including an optical scanner.

See [1.1] of Ground 2.

3. [33.2] wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment

399. Kriveshko discloses wherein the 3D environment to be scanned is selected by pointing the optical scanner at the 3D environment. *See* [1.2] of Ground 2.

4. [33.3] at least one display remotely connected to the handheld device

400. Kriveshko discloses at least one display remotely connected to the handheld device. *See* [33.3] of Ground 2.

5. [33.4] wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment

401. Kriveshko discloses wherein the handheld device is adapted for performing at least one scanning action in a physical 3D environment. *See* [1.3] of Ground 2.

6. [33.5] the at least one display is adapted for visually representing the physical 3D environment

402. Kriveshko discloses the at least one display is adapted for visually representing the physical 3D environment. *See* [1.4] of Ground 2.

7. [33.6] wherein the handheld device includes at least one motion sensor for remotely controlling the display to

**adjust the view with which the 3D environment is
represented on the display**

403. The combination of Kriveshko and Serra discloses wherein the handheld device includes at least one motion sensor for remotely controlling the display to adjust the view with which the 3D environment is represented on the display. *See* [1.5] and [1.6] of Ground 2.

**8. [33.7] wherein the at least one motion sensor is an
accelerometer, gyro, or magnetometer.**

404. The combination of Kriveshko, Serra, and Marvit discloses wherein the at least one motion sensor is an accelerometer, gyro, or magnetometer. *See* [1.7] of this Ground.

X. Claim 34

405. Claim 34 is obvious over the combination of Kriveshko, Serra, and Marvit.

**1. [34.0] 34. The scanning system according to claim 33,
wherein the handheld device further comprises at least
two user interface elements.**

406. Kriveshko discloses wherein the handheld device further comprises at least two user interface elements. *See* [34.0] of Ground 2.

Y. Claim 40

407. Claim 40 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[40.0] 40. The scanning system according to claim 1, wherein the at least one display is a 3D display**

408. The combination of Kriveshko and Serra discloses wherein the at least one display is a 3D display. *See* [40.0] of Ground 2.

2. **[40.1] whereby a 3D representation of the 3D environment is displayed on the 3D display**

409. The combination of Kriveshko and Serra discloses whereby a 3D representation of the 3D environment is displayed on the 3D display. *See* [40.1] of Ground 2.

3. **[40.2] wherein the handheld device is an intra-oral 3D scanner or an in-ear 3D scanner.**

410. The combination of Kriveshko and Serra discloses wherein the handheld device is an intra-oral 3D scanner or an in-ear 3D scanner. *See* [40.2] of Ground 2.

Z. Claim 41

411. Claim 41 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[41.0] 41. The scanning system according to claim 40, wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation.**

412. The combination of Kriveshko and Serra discloses wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation. *See* [41.0] of Ground 2.

AA. Claim 42

413. Claim 42 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[42.0] 42. The scanning system according to claim 40, wherein the 3D display is volumetric display configured to create a 3D effect of the 3D representation.**

414. The combination of Kriveshko and Serra discloses wherein the 3D display is volumetric display configured to create a 3D effect of the 3D representation. *See* [42.0] of Ground 2.

BB. Claim 43

415. Claim 43 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[43.0] 43. The system according to claim 19, wherein the at least one display is a 3D display**

416. The combination of Kriveshko and Serra discloses wherein the at least one display is a 3D display. *See* [43.0] of Ground 2.

2. **[43.1] whereby a 3D representation of the 3D environment is displayed on the 3D display**

417. The combination of Kriveshko and Serra discloses whereby a 3D representation of the 3D environment is displayed on the 3D display. *See* [43.1] of Ground 2.

3. **[43.2] wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation**

418. The combination of Kriveshko and Serra discloses wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation. *See* [43.2] of Ground 2.

CC. Claim 44

419. Claim 44 is obvious over the combination of Kriveshko, Serra, and Marvit.

1. **[44.0] 44. The scanning system according to claim 33, wherein the at least one display is a 3D display,**

420. The combination of Kriveshko and Serra discloses wherein the at least one display is a 3D display. *See* [44.0] of Ground 2.

2. **[44.1] whereby a 3D representation of the 3D environment is displayed on the 3D display**

421. The combination of Kriveshko and Serra discloses whereby a 3D representation of the 3D environment is displayed on the 3D display. *See* [44.1] of Ground 2.

3. **[44.2] wherein the handheld device is an intra-oral 3D scanner or an in-ear 3D scanner**

422. The combination of Kriveshko and Serra discloses wherein the handheld device is an intra-oral 3D scanner or an in-ear 3D scanner. *See* [44.2] of Ground 2.

4. **[44.3] wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation**

423. The combination of Kriveshko and Serra discloses wherein the 3D display is configured to project stereoscopic image pairs of the 3D representation. *See* [44.3] of Ground 2.

XIII. GROUND 6: CLAIM 30 IS OBVIOUS OVER KRIVESHKO, SERRA, MARVIT, AND QUAID

A. Claim 30

424. Claim 30 is obvious over the combination of Kriveshko, Serra, Marvit, and Quaid.

1. [30.0] 30. The scanning system according to claim 1, wherein the at least one display is arranged on a cart.

425. The combination of Kriveshko, Serra, Marvit, and Quaid discloses wherein the at least one display is arranged on a cart. Quaid discloses placing monitors on carts. EX1111, ¶0093. Quaid explains that placing a system on a cart provides ease of mobility for the system and allows it to be moved to a location necessary for a given procedure. EX1111, ¶0096. “For example, as shown in Fig. 1 of Quaid below, the display device 23 may be disposed on an adjustable arm (not shown) that is connected to the cart 29 or to any other location well-suited for ease of viewing by the user.” EX1111, ¶0093.

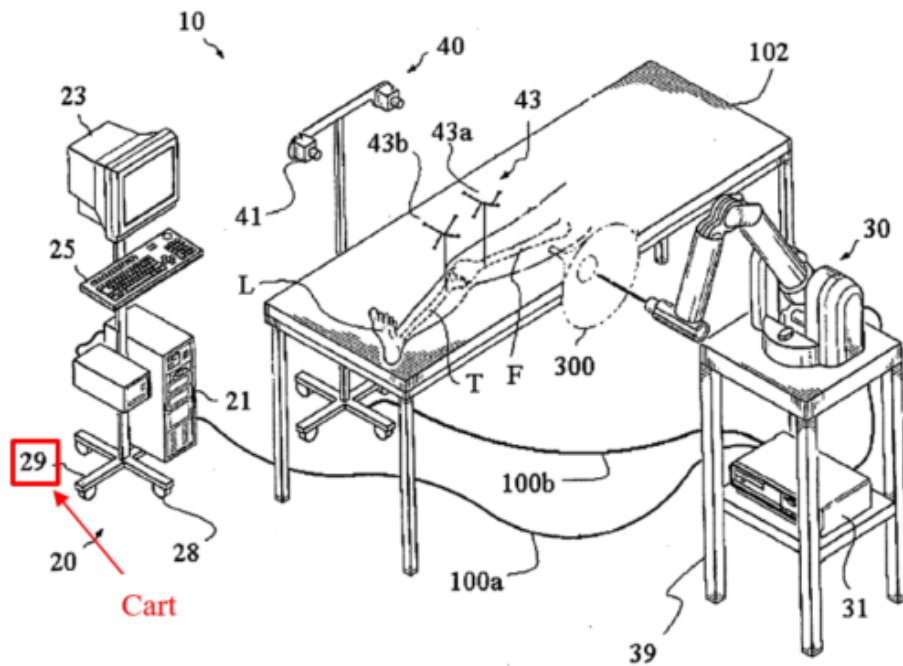


FIG. 1

426. It would have been obvious to place at least one monitor of the combination of Kriveshko, Serra, and Marvit on a cart. A POSA would have a reasonable expectation of successfully arranging a display on a cart if desired.

I hereby declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true I understand that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. § 1001).

Executed on October 26, 2022


KURTIS KELLER