

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

3SHAPE A/S and 3SHAPE INC.
Petitioners

v.

MEDIT CORPORATION
Patent Owner

Case No. IPR2024-01268
Patent 9,191,648

**DECLARATION OF ELI SABER IN SUPPORT OF
PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 9,191,648**

3SHAPE EXHIBIT 1016
3Shape v. Medit

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5.	[23.5]: to refine the combined model with a global motion optimization of the virtual stitch graph; and	84

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APPENDIX A

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EXHIBIT	DESCRIPTION
1001	U.S. Patent No. 9,191,648, issued on November 17, 2015 to I. Kriveshko and B. Frantzdale (“the ’648 Patent”)
1002	File History of U.S. Patent Application No. 14/000,442, filed on August 20, 2013
1003	International PCT Publication No. WO 2012/115863, published on August 30, 2012 (Int’l Appln. No. PCT/US12/25554)
1004	U.S. Provisional Application No. 61/445,464, filed on February 22, 2011
1005	U.S. Patent Application Publication No. 2007/0171220 (“Kriveshko”)
1006	International Publication No. WO 2009/089129 (“Zhang”)
1007	U.S. Patent No. 8,401,225 (“Newcombe”)
1008	Estépar, R. S. J., Brun, A., & Westin, C. F. (2004). Robust generalized total least squares iterative closest point registration. In <i>Medical Image Computing and Computer-Assisted Intervention–MICCAI 2004: 7th International Conference, Saint-Malo, France, September 26-29, 2004. Proceedings, Part I</i> , pp. 234-241, Springer Berlin Heidelberg
1009	Szeliski, R. (2006). <i>Image Alignment and Stitching: A Tutorial, Foundations and Trends in Computer Graphics and Vision</i> , vol. 2, issue 1, pp. 1-104
1010	U.S. Patent Application Publication No. 2007/0172112 (“Paley”)
1015	Claim Construction Order for U.S. Patent Nos. 7,912,257; 9,191,648; 9,245,374; 9,262,864 filed on May 31, 2024 in <i>Medit Corporation v. 3Shape A/S</i> , Civ. Action No. 6:23-cv-00658 (WDTX)

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EXHIBIT	DESCRIPTION
1017	<i>Curriculum Vitae</i> of Eli Saber, Ph.D.

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I, Eli Saber, hereby state as follows:

I. INTRODUCTION

1. I have been retained by Buchanan Ingersoll & Rooney (“Counsel”) on behalf of 3SHAPE A/S (“Petitioner”) as an independent expert consultant in this *inter partes* review (“IPR”) proceeding before the United States Patent and Trademark Office (“PTO”).

2. I have been asked by Counsel to provide opinions regarding Claims 1-24 of U.S. Patent No. 9,191,648 (“the ’648 Patent”). My opinions and the bases for my opinions are set forth below.

3. I am being compensated at my ordinary and customary consulting rate for my work, which is \$500 per hour. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other financial interest in this proceeding.

4. This report is based on information currently available to me. I reserve the right to continue my investigation and analysis, which may include a review of documents and information not listed above. I also reserve the right to expand or otherwise modify my opinions and conclusions as my investigation and study

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continues, and to supplement my opinions and conclusions in response to any additional information that becomes available to me.

II. BACKGROUND AND QUALIFICATIONS

5. All my opinions stated in this declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in designing, developing, researching, and teaching the technology referenced in this declaration.

6. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein. I understand that a copy of my current curriculum vitae, which details my education and professional and academic experience, is being submitted as EX1017. The following provides a brief overview of some of my experience that is relevant to the matters set forth in this declaration.

7. I am a Professor in the Department of Electrical and Microelectronic Engineering (EME) and the Chester F. Carlson Center for Imaging Science at the Rochester Institute of Technology (RIT) in Rochester, New York. I also serve as the Director of the Image, Video and Computer Vision Laboratory. I joined RIT's full-time faculty in 2004. I have over thirty-four (34) years of industry and academic experience, thirty (30) of which are in the fields of Computer Vision, Digital Image/Video Processing, Pattern Recognition, and Machine Learning.

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8. I received a Ph.D. in Electrical Engineering from the University of Rochester in 1996. My concentration was in Signal/Image/Video Processing, Pattern Recognition, and Computer Vision. I received a Master of Science Degree in Electrical Engineering from the University of Rochester in 1992 in the same concentration as listed above, and I received a Bachelor of Science Degree in Electrical and Computer Engineering, Summa Cum Laude, from the State University of New York at Buffalo in 1988.

9. Before becoming a full-time professor, I worked for Xerox Corporation for 16 years, from 1988 to 2004. During my years at Xerox, I was responsible for delivering color management, image processing innovations, architectures, and algorithms; xerographic sub-systems for a variety of color products; and control systems for toner production facilities. One of several roles I held at Xerox was Advanced Development Scientist and Manager. In that capacity, I established the Advanced Design Laboratory—an Imaging/Xerographics lab—and provided technical and managerial leadership for the Electrical, Imaging and Xerographics Department. In another role, as Product Development Scientist and Manager, I led the research and development of image quality metrics for various product platforms. I also led the Image Science, Analysis, and Evaluation area, with 12 to 15 direct reports and a budget of approximately \$2 million.

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10. From 1997 until 2004, I was an adjunct faculty member at the Electrical Engineering Department of the Rochester Institute of Technology and at the Electrical & Computer Engineering Department of the University of Rochester. I was responsible for teaching undergraduate and graduate coursework such as Digital Signal Processing, Digital Image Processing, Digital Video Processing, Pattern Recognition, Detection and Estimation Theory and Communication Systems; and performing research in multimedia applications, pattern recognition, image understanding and color engineering.

11. Since joining RIT full time, I have been responsible for teaching several undergraduate and graduate courses in Digital Signal Processing, Digital Image Processing, Digital Video Processing, Pattern Recognition, Advanced Neural Networks and Deep Learning, Engineering Analysis, Random Signal & Noise, Advanced Engineering Mathematics, Matrix Methods, Communications, Modern Control Theory, and Linear Systems.

12. I proposed, developed and introduced the Digital Video Processing and the Advanced Neural Network and Deep Learning courses; and reestablished the Pattern Recognition course at the Electrical Engineering Department at RIT. These graduate courses were instrumental in providing MS/PhD students with the proper

foundation and knowledge in all aspects of the subject areas in order to perform in-depth research in the field and continue to advance the state of the art.

13. The Digital Video Processing course is designed to provide a thorough and comprehensive coverage of the field. Topics covered include the mathematical representation of digital video including motion and time-varying image formation models, spatio-temporal sampling/reconstruction, sampling structure conversions, motion estimation using optical flow, block-based, pel-recursive, Bayesian and point correspondence type methodologies, segmentation, motion tracking, filtering, restoration, super-resolution and image/video compression.

14. The Pattern Recognition course, on the other hand, covers pertinent concepts in Bayes decision theory, linear and nonlinear classifiers, artificial neural networks, feature selection/generation/extraction and various types of clustering algorithms and techniques.

15. The “Advanced Neural Networks and Deep Learning: Theory, Mathematics and Algorithms” is intended to provide an in-depth comprehensive study of the theory, mathematics and algorithms for advanced neural networks and their usage in deep learning. It is primarily targeted for upper graduate students that are planning to pursue advanced studies/research in the field. The course begins with an in-depth study of the mathematical methodologies for neural networks and

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optimization (zero-, first- and second-order) techniques. It then progresses to provide a thorough study of shallow and deep neural networks architectures and algorithms, activation functions, regression, two- and multi-class classification, unsupervised learning, feature engineering/selection, backpropagation along with applications to a variety of engineering problems.

16. I am currently working to develop a follow-on course (part 2) to the Advanced Neural Networks and Deep Learning course described above. This course is intended to cover convolutional and recurrent style neural networks, principles of feature engineering, kernel methods, tree-based learners, attention mechanisms/transformers, reinforcement learning and generative adversarial networks. This course is being targeted to debut in Fall 2025.

17. My current research focuses on machine learning for object tracking/remote sensing applications; image/video processing for multimedia, military & biomedical applications; and computer vision and three-dimensional scene reconstruction. As a principal investigator (PI) or co-principal investigator, I have acquired almost \$6 million in research funding since joining RIT and have managed multiple government grants from the Department of Defense as well as several corporate grants from Hewlett-Packard, Lenel, and Data Physics. I am currently managing (as PI) a multiyear government grant from the Department of

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Defense titled “Target Detection/Tracking and Activity Recognition from Multimodal Data.” In this project, we propose to develop operational target detection/tracking techniques and activity recognition/understanding methods that can leverage multimodal data in a fusion framework using deep learning algorithms while providing accurate and near real-time performance.

18. In 2012, I was awarded the Prestigious Trustees Scholarship, the highest award at RIT with regard to research recognition.

19. I am the author or co-author of thirty-eight (38) peer-reviewed journal publications.

20. I have also authored or co-authored 102 conference and workshop publications and a book entitled Advanced Linear Algebra for Engineers with MATLAB, published by CRC Press in February 2009, and am a named inventor on multiple U.S. and foreign patents.

21. I am a senior member of the Institute of Electrical and Electronic Engineers and a member of the IEEE Signal Processing Society, the Electrical Engineering Honor Society, Eta Kappa Nu.

22. A detailed record of my professional qualifications, including a list of publications, awards, and professional activities, is set forth in my curriculum vitae and is attached to this report as Appendix A.

III. INFORMATION CONSIDERED

23. In preparing this declaration, I have reviewed the '648 Patent and the exhibits and documents referenced herein. In addition, my opinions are further based on my education, training, experience, and knowledge in the relevant field.

IV. RELEVANT LEGAL STANDARDS

24. I am not an attorney and offer no legal opinions. For the purposes of this Declaration, I have been informed about certain aspects of the law that are relevant to my analysis, as summarized below.

A. Claim Interpretation

25. I have been informed that during an *inter partes* review proceeding, claims are to be construed in light of the specification as would be read by a person of ordinary skill in the relevant art at the time the application was filed. I have been informed that claim terms are given their ordinary and customary meaning as would be understood by a person of ordinary skill in the relevant art in the context of the entire disclosure. A claim term, however, will not receive its ordinary meaning if the patentee acted as his own lexicographer and clearly set forth a definition of the claim term in the specification. In that case, the claim term will receive the definition set forth in the patent.

B. Perspective of One of Ordinary Skill in the Art

26. I have been informed that a patent is to be understood from the perspective of a hypothetical “person of ordinary skill in the art” (“POSITA”). Such an individual is considered to possess normal skills and knowledge in a particular technical field (as opposed to being a genius). I have been informed that in considering what the claims of a patent require, what was known prior to that patent, what a prior art reference discloses, and whether an invention is obvious or not, one must use the perspective of such a POSITA.

C. Anticipation

27. I have been informed that a claim is not patentable if it is anticipated. I have been informed that anticipation of a claim requires that every element of a claim is disclosed expressly or inherently in a prior art reference, arranged as in the claim, when considered from the perspective of a person of ordinary skill in the relevant art. I have been informed that when the structure recited in a reference is substantially identical to that of the claims, claimed properties or functions are presumed to be inherent. I have been informed that extrinsic evidence may be used to explain but not expand the meaning of terms and phrases used in the reference relied upon as anticipatory of the claimed subject matter.

D. Obviousness

28. I have been informed that a patent claim is obvious under 35 U.S.C. §103, and therefore invalid, if the claimed subject matter, as a whole, would have been obvious to a POSITA as of the priority date of the patent based on one or more prior art references and/or the knowledge of a POSITA.

29. I have been informed that an obviousness analysis must consider (1) the scope and content of the prior art, (2) the differences between the claims and the prior art, (3) the level of ordinary skill in the pertinent art, and (4) secondary considerations, if any, of non-obviousness (such as unexpected results, commercial success, long-felt but unmet need, failure of others, copying by others, and skepticism of experts).

30. I have been informed that a prior art reference may be combined with other references to disclose each element of the invention under 35 U.S.C. §103. I have been informed that a reference may also be combined with the knowledge of a POSITA, and that this knowledge may be used to combine multiple references. I have been informed that a POSITA is presumed to know the relevant prior art. I have been informed that the obviousness analysis may take into account the inferences and creative steps that a POSITA would employ.

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31. In determining whether a prior art reference would have been combined with other prior art or other information known to a POSITA, I have been informed that the following principles may be considered:

- whether the references to be combined involve non-analogous art;
- whether the references to be combined are in different fields of endeavor than the alleged invention in the patent;
- whether the references to be combined are reasonably pertinent to the problems to which the inventions of the patent are directed;
- whether the combination is of familiar elements according to known methods that yields predictable results;
- whether a combination involves the substitution of one known element for another that yields predictable results;
- whether the combination involves the use of a known technique to improve similar items or methods in the same way that yields predictable results;
- whether the combination involves the application of a known technique to a prior art reference that is ready for improvement, to yield predictable results;

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- whether the combination is “obvious to try”;
- whether the combination involves the known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces, where the variations are predictable to a POSITA;
- whether there is some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill in the art to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention;
- whether the combination requires modifications that render the prior art unsatisfactory for its intended use;
- whether the combination requires modifications that change the principle of operation of the reference;
- whether the combination is reasonably expected to be a success; and
- whether the combination possesses the requisite degree of predictability at the time the invention was made.

32. I have been informed that in determining whether a combination of prior art references renders a claim obvious, it is helpful to consider whether there is

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some teaching, suggestion, or motivation to combine the references and a reasonable expectation of success in doing so. I have been informed, however, that a teaching, suggestion, or motivation to combine is not required.

V. SUMMARY OF OPINIONS

33. It is my opinion that Claims 1-24 of the '648 Patent are unpatentable under 35 U.S.C. §103 at least under the grounds discussed below.

VI. IDENTIFICATION OF CHALLENGES TO THE CLAIMS

34. The '648 Patent contains 24 claims. I have been asked to opine on the validity of Claims 1-24. Grounds 1 and 2, which are discussed below in greater detail, are as follows:

Ground	References	Basis	Claims Challenged
1	US Patent Application Publication No. 2007/0171220 ("Kriveshko", EX1005) and International Publication No. WO 2009/089129 ("Zhang", EX1006)	§103	1-24

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Ground	References	Basis	Claims Challenged
2	Kriveshko (EX1005) and Zhang (EX1006), further in view of Estépar, R. S. J., Brun, A., & Westin, C. F. (2004). Robust generalized total least squares iterative closest point registration. In <i>Medical Image Computing and Computer-Assisted Intervention—MICCAI 2004: 7th International Conference, Saint-Malo, France, September 26-29, 2004. Proceedings</i> , Part I, pp. 234-241, Springer Berlin Heidelberg (EX1008) and Szeliski, R. (2006). <i>Image Alignment and Stitching: A Tutorial, Foundations and Trends in Computer Graphics and Vision</i> , vol. 2, issue 1, pp. 1-104 (EX1009)	§103	4, 7

VII. LEVEL OF ORDINARY SKILL IN THE ART

35. I have been informed that a POSITA is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity.

36. I believe that a POSITA would have at least (1) a bachelor's degree in electrical engineering, computer engineering, computer science or an equivalent field, as well as at least two to three years of industry or research experience with

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computer vision/graphics making use of three-dimensional virtual models; or (2) a master's degree in electrical engineering, computer engineering, computer science or an equivalent field with a focus in making use of three-dimensional virtual models in the area of computer vision/graphics.

VIII. TECHNICAL BACKGROUND

A. The '648 Patent

37. I understand that the '648 Patent issued on November 17, 2015 from U.S. Application 14/000,442 ("the '442 Application"), which is a National Stage of PCT International Application No. PCT/US2012/025554 (EX1003), filed on February 17, 2012, which claims priority to U.S. Provisional Application No. 61/445,464 (EX1004), filed on February 22, 2011.

38. The '648 Patent discloses that the purported invention relates to three-dimensional imaging and more specifically to techniques for combining disparate scans of a common three-dimensional surface. EX1001, 1:5-7.

39. The '648 Patent discloses a system or method where three-dimensional data is acquired as a sequence of frames of data along a camera path. EX1001, 1:35-40, 4:15-21.

40. Figure 9 of the '648 Patent is a flow chart of a hybrid stitching process for combining disparate three-dimensional scans of a common surface. EX1001, 18:15 to 19-61.

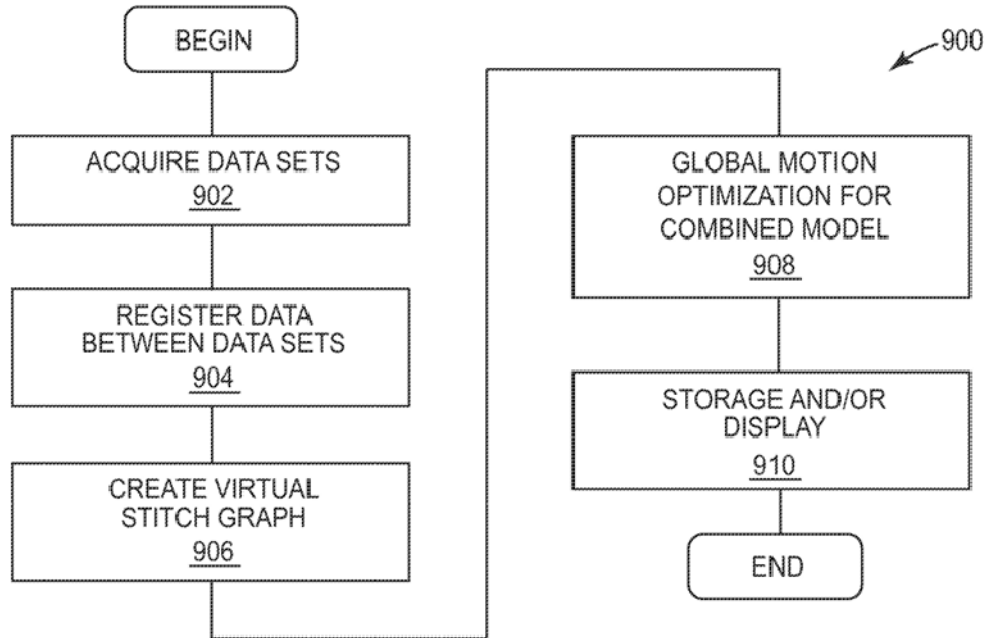


FIG. 9

Figure 9 of the '648 Patent

41. The '648 Patent purports to provide a novel technique that combines “disparate” scans of a common three-dimensional surface. EX1001, 1:5-7, 18:17-21.

42. The '648 Patent discloses examples of a “disparate” scan:

The second model may, for example, be obtained *after a first scan is automatically or manually interrupted, or after a first scan is completed and additional data is required or desired*, either by a user or in response to prompting from a scanning system as contemplated above. More generally, the second three-dimensional model may be any disparate data set that is not directly spatially related to the first three-dimensional model through a single scan or camera path. [Emphasis added.]

EX1001, 18:47-55. Thus, according to the '648 Patent, a “disparate” scan encompasses a scan that is obtained after an interruption or completion of an initial scan, for example, “after a first scan is completed and additional data is required or desired”. EX1001, 18:47-55.

43. Combining disparate scans is nothing new. As discussed below, Kriveshko discloses techniques for fitting and stitching data from disparate scans “where a scan is purposely interrupted by the user” as well as where scans “have been lost due to signal degradation or scans that have been explicitly stopped through user operation”. EX1005, [0074]. *See also* EX1005, [0059].

B. Overview of the Prior Art

1. Kriveshko (EX1005)

44. Kriveshko discloses registration and stitching of two disparate 3D models obtained from scanning tooth surfaces within a dental patient’s mouth. EX1005, [0005], [0008], [0100], [0103].

45. Kriveshko discloses techniques for combining newly acquired data—for example, obtained after an interruption in scanning—with previously acquired data. EX1005, [0005], [0008], [0100], [0103].

46. Kriveshko relates to “three-dimensional scanning” and provides “techniques for resuming a three-dimensional scan after losing data acquisition.” EX1005, [0002].

47. Kriveshko’s methods and systems are particularly useful in dentistry applications. EX1005, [0008] (“a full three-dimensional surface scan may be obtained for two dental arches in occlusion”). *See also* EX1005, [0054], [0100].

48. Kriveshko discloses “techniques that identify and aid in recovery from errors in incremental scans” and “real time feedback systems to support recovery from a lost scanning sequence while the scan is in progress.” EX1005, [0007].

49. For example, Kriveshko discloses techniques that address the problem when fitting or stitching fails. EX1005, [0059].

50. As discussed below, Kriveshko discloses techniques for fitting and stitching data from separate scans “where a scan is purposely interrupted by the user” and “after a first scan is completed and additional data is desired”, as well as where scans “have been lost due to signal degradation or scans that have been explicitly stopped through user operation”. EX1005, [0074].

51. Kriveshko discloses exemplary techniques for operating an image capture system in Figures 2 and 3.

2. Zhang (EX1006)

52. Zhang relates to three-dimensional imaging and discloses techniques for optimizing the calculation of a global camera path used in a three-dimensional reconstruction. EX1006, [0002].

53. Zhang discloses that its techniques and systems are applicable to dental applications and scanning of “human dentition” and “tooth surface[s]”. EX1006, [0023], [0027]-[0034].

54. Zhang is entitled “Global Camera Path Optimization” and discloses the same “global motion optimization” as the ’648 Patent. EX1006, [0045]. The ’648 Patent describes “global motion optimization” as follows, and Zhang contains a word-for-word identical description:

In the systems and methods described herein, a number of techniques for global motion optimization are employed

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to improve accuracy of three-dimensional reconstructions based upon camera path. [EX1001, 2:16-19; EX1006, [0022].]

Global motion optimization, also referred to herein as global path optimization or global camera path optimization, may be performed by a global motion optimization module 357 in order to reduce errors in the resulting three-dimensional model 358. [EX1001, 8:57-61; EX1006, [0045].]

55. Figure 3 of Zhang—which is identical to Figure 3 of the '648 Patent—depicts use of a global motion optimization module 357 which, as described above, provides means for refining and “reduc[ing] errors in the resulting three-dimensional model”. EX1006, [0045].

56. The '648 Patent discloses examples of global motion optimization techniques. Zhang discloses the exact same techniques.

57. Both the '648 Patent and Zhang disclose, in identical fashion, a global motion optimization technique involving minimizing accumulation of errors along the length of the camera path by supplemental frame-to-frame motion estimation with some or all of the global path information. EX1001, 8:63-9:14; EX1006, [0045].

58. Both the '648 Patent and Zhang disclose, in identical fashion, a global motion optimization technique involving reducing errors in the calculated camera path based upon available data for the complete camera path such as, for example, cross links that interrelate temporally distant measurements. EX1001, 12:25-33; EX1006, [0060].

3. Estépar (EX1008) and Szeliski (EX1009)

59. Estépar is entitled “Robust Generalized Total Least Squares Iterative Closest Point Registration”. Szeliski is entitled “Image Alignment and Stitching: A Tutorial”. Estépar and Szeliski disclose well known registration techniques that were available to a POSITA for implementing the techniques disclosed by Kriveshko, including iterative closest point (ICP) algorithm. *See e.g.*, EX1008, abstract; EX1009, 36-37. I have been informed that Kriveshko, Zhang, Estépar, and Szeliski all qualify as prior art with respect to the '648 Patent.

IX. CLAIM CONSTRUCTION

60. For purposes of my analysis in this IPR proceeding, I have been informed that terms that appear in the claims of the '648 Patent should be interpreted according to their plain and ordinary meaning under the *Phillips* standard. In determining the ordinary and customary meaning, I have been informed that the words of a claim are first given their plain meaning that those words would have had

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to a POSITA at the time of the alleged invention. I also have been informed that the claims, specification, and file history may be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. I have been informed that even treatises and dictionaries may be used under limited circumstances to determine the meaning attributed by a POSITA to a claim term at the time of filing.

A. “(first/second) three-dimensional model”

61. In the Related Litigation, Petitioners asserted that the term “(first/second) three-dimensional model” (Claims 1, 2, 12, 13, 23, 24) refers to “a disparate data set that is not directly related to another three-dimensional model through a single scan or camera path.” EX1015, pp. 2-3. Patent Owner asserted that this term should be given its plain and ordinary meaning. EX1015, pp. 2-3. The District Court construed the term as having its plain and ordinary meaning. EX1015, pp. 2-3.

B. “camera path”

62. In the Related Litigation, Petitioners asserted that the term “camera path” (Claims 1, 12, 23, 24) refers to “physical path(s) taken by a scanner during a scan.” EX1015, pp. 2-3. Patent Owner asserted that this term should be given its plain and ordinary meaning. EX1015, pp. 2-3. The District Court construed the term as having its plain and ordinary meaning. EX1015, pp. 2-3.

C. “virtual stitch graph”

In the Related Litigation, Petitioners asserted that the term “virtual stitch graph” (Claims 1, 19, 12, 20, 23, 24) refers to “spatial relationship between models using data from disparate models.” EX1015, pp. 2-3. Patent Owner asserted that the term refers to “rigid transformation and/or other descriptive data that characterizes camera motion in a manner that permits path-based reconstruction of a 3D surface based on multiple disparate scans.” EX1015, pp. 2-3. The District Court construed this term as “spatial relationship between data sets and/or models using data from disparate data sets and/or models.” EX1015, pp. 2-3.

D. “scanning means”, “processing means”

63. Claim 24 recites the terms “scanning means” and “processing means”. In the Related Litigation, the District Court and both parties did not construe any claim term of the ’648 Patent as a means-plus-function or step-plus-function limitation under §112(6)/112(f). EX1015.

64. I understand that, for purposes of compliance with USPTO rules, Petitioners have submitted that the function of the “scanning means” is scanning for obtaining a first three-dimensional model including a first plurality of sets of three-dimensional points spatially related to one another by a first camera path, and a second three-dimensional model including a second plurality of sets of three-

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dimensional points spatially related to one another by a second camera path. I understand that, for purposes of compliance with USPTO rules, Petitioners submit that the corresponding structure encompasses the following: a scanner that captures images from a surface of an object (EX1001, 4:17-18); any camera or camera system suitable for capturing images from which a three-dimensional point cloud or other three-dimensional data may be recovered (EX1001, 4:26-29); and/or 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 such as starting and stopping scans (EX1001, 5:4-9).

65. I understand that, for purposes of compliance with USPTO rules, Petitioners submit that the function of the “processing means” is registering one of the first plurality of sets of three-dimensional points to one of the second plurality of sets of three-dimensional points to place the first three-dimensional model and the second three-dimensional model in a shared coordinate system, creating a virtual stitch graph that spatially relates the first plurality of sets and the second plurality of sets, thereby providing a combined model that includes the first plurality of sets and the second plurality of sets all spatially related by the virtual stitch graph, and refining the combined model with a global motion optimization of the virtual stitch graph. I understand that, for purposes of compliance with USPTO rules, Petitioners

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submit that the corresponding structure encompasses the following: a personal computer or other processing device (EX1001, 5:58-63); one or more microprocessors, microcontrollers, embedded microcontrollers, programmable digital signal processors or other programmable devices, along with internal and/or external memory (EX1001, 22:19-23); one or more application specific integrated circuits, programmable gate arrays, programmable array logic components; and/or any other device or devices that may be configured to process electronic signals (EX1001, 22:23-27).

66. I have reviewed the '648 Patent (EX1001) and its prosecution history (EX1002) as well as additional documents (*see* Exhibit List). In my analysis below, I have addressed the District Court's constructions for each of the above claim terms. *See* EX1015. I have also addressed the constructions submitted by Petitioners and Patent Owner in the Related Litigation. *See* EX1015. The Challenged Claims (Claims 1-24 of the '648 Patent) are unpatentable under any of the constructions for the reasons discussed below.

X. CLAIMS 1-24 WOULD HAVE BEEN OBVIOUS OVER KRIVESHKO IN VIEW OF ZHANG (GROUND 1).

67. In my opinion, Claims 1-24 of the '648 Patent are unpatentable over the prior art asserted in Ground 1.

68. The following sections explain where each element of these claims is found in this prior art.

A. Claim 1 (Preamble): A method comprising:

69. In my opinion, Kriveshko discloses and suggests the Preamble of Claim 1.

70. Kriveshko discloses methods and systems for “three-dimensional scanning” including “techniques for resuming a three-dimensional scan after losing data acquisition.” EX1005, [0002].

71. Kriveshko discloses methods and systems that acquire three-dimensional images and are useful in dentistry applications, for example, “a full three-dimensional surface scan may be obtained for two dental arches in occlusion”. EX1005, [0008].

72. Kriveshko discloses “techniques that identify and aid in recovery from errors in incremental scans” and “real time feedback systems to support recovery from a lost scanning sequence while the scan is in progress.” EX1005, [0007].

73. Kriveshko discloses combining newly acquired data—for example, obtained after an interruption in scanning—with previously acquired data. EX1005, [0005], [0008], [0059], [0100].

74. For example, Kriveshko discloses that “[f]rom time to time in such incremental data acquisition systems, the fitting or stitch may fail” and Kriveshko provides techniques (*e.g.*, a “recover mode” and a “landing mode”) that “seek to reacquire the previous scan by test fitting new scan data to previously acquired data” and “initiate a new scan registered or connected to an existing three-dimensional model”. EX1005, [0059].

75. Kriveshko discloses exemplary techniques for operating an image capture system in Figures 2 and 3.

1. [1.1]: obtaining a first three-dimensional model including a first plurality of sets of three-dimensional points spatially related to one another by a first camera path;

76. In my opinion, Kriveshko discloses and suggests Element [1.1].

77. Kriveshko discloses “providing three-dimensional surface data for a subject, and acquiring an image set for a three-dimensional image of the subject”. EX1005, [0011]. *See also* EX1005, [0008].

78. Kriveshko discloses “acquiring at least one subsequent three-dimensional image; fitting the at least one subsequent three-dimensional image to a second three-dimensional surface reconstruction; and test fitting the at least one subsequent three-dimensional image to the three-dimensional surface data.” EX1005, [0011].

79. Kriveshko discloses obtaining a “new” (second) three-dimensional model and adding/fitting same to an “original” (first) three-dimensional model obtained from a previous scan. EX1005, [0059] (“reacquire the previous scan by test fitting new scan data to previously acquired data”), [0070] (“new or incremental three-dimensional data may be added to the three-dimensional model”), [0074], [0097] (“create a supplemental three-dimensional model ... before a successful fit to the original three-dimensional model”).

80. Kriveshko discloses that the terms “three-dimensional image” and “three-dimensional data” are “used interchangeably” with “three-dimensional model”. EX1005, [0061] (“the terms three-dimensional data, three-dimensional representation, three-dimensional model, three-dimensional image, three-dimensional surface map, and the like are used interchangeably to describe the three-dimensional representation assembled from incremental scan results captured by the scanning device, or a portion thereof....”). *See also* EX1005, [0063].

81. Kriveshko’s techniques relate to obtaining and combining first and second three-dimensional models, given that Kriveshko discloses techniques for combining newly acquired three-dimensional images/data (*e.g.*, obtained after an interruption in scanning) with previously acquired three-dimensional images/data. EX1005, [0005], [0100]. *See also* EX1005, [0008] (“[a] scanning system that

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acquires three-dimensional images as an incremental series of fitted three-dimensional data sets is improved by testing for successful incremental fits in real time and providing a variety of visual user cues and process modifications depending upon the relationship of newly acquired data to previously acquired data.”).

82. Further, the '648 Patent discloses that the term “three-dimensional model” encompasses “any three-dimensional surface map of an object, such as a point cloud of surface data, a set of two-dimensional polygons, ***or any other data representing all or some of the surface of an object***, as might be obtained through the capture and/or processing of three-dimensional scan data”. EX1001, 2:54-63 (emphasis added).

83. The three-dimensional data and three-dimensional images disclosed by Kriveshko constitute “three-dimensional models” as claimed at least because they constitute “data representing all or some of the surface of an object”. EX1001, 2:54-63.

84. Kriveshko discloses first and second “three-dimensional models” under all constructions (*see* §IX.A.). Concerning Petitioners’ construction, according to the '648 Patent, “disparate” scans, data sets, and models encompass an embodiment in which a second model is “obtained after a first scan is automatically or manually

interrupted, or after a first scan is completed and additional data is required or desired”. EX1001, 18:47-55.

85. The '648 Patent discloses that “the full scan data for an object may include any number of disparate scans with camera paths, or more generally stitch graphs, that are not directly spatially related to one another.” EX1001, 18:17-21.

86. Like the '648 Patent, Kriveshko is directed to techniques for fitting and stitching disparate data sets and models obtained from disparate scans “where a scan is purposely interrupted by the user” as well as where scans “have been lost due to signal degradation or scans that have been explicitly stopped through user operation”. EX1005, [0074]. *See also* EX1005, [0059].

87. Kriveshko discloses that in such situations, the system “may seek to reacquire the previous scan by test fitting new scan data to previously acquired data” and “a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model.” EX1005, [0059].

88. Kriveshko discloses “techniques for resuming a three-dimensional scan after losing data acquisition.” EX1005, [0002].

89. Kriveshko discloses registration and stitching of two disparate 3D models to address the problem of “errors or gaps in incremental data” during intraoral scanning and seeks to combine newly acquired data—for example,

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obtained after an interruption in or completion of scanning—with previously acquired data. EX1005, [0005], [0008], [0100].

90. Such newly acquired data constitutes “a disparate data set that is not directly related to another three-dimensional model through a single scan or camera path” with respect to the previously acquired data.

91. Exhibit 1010 (Paley) further demonstrates that it was well known to “acquire additional data where a void or deviation is detected” in the initial digital model.¹ EX1010, [0060].

¹ I have been informed that Paley (EX1010), published on July 26, 2007, constitutes prior art at least under 35 U.S.C. §102(b).

92. Figure 2 of Kriveshko discloses an exemplary process for 3D scanning:

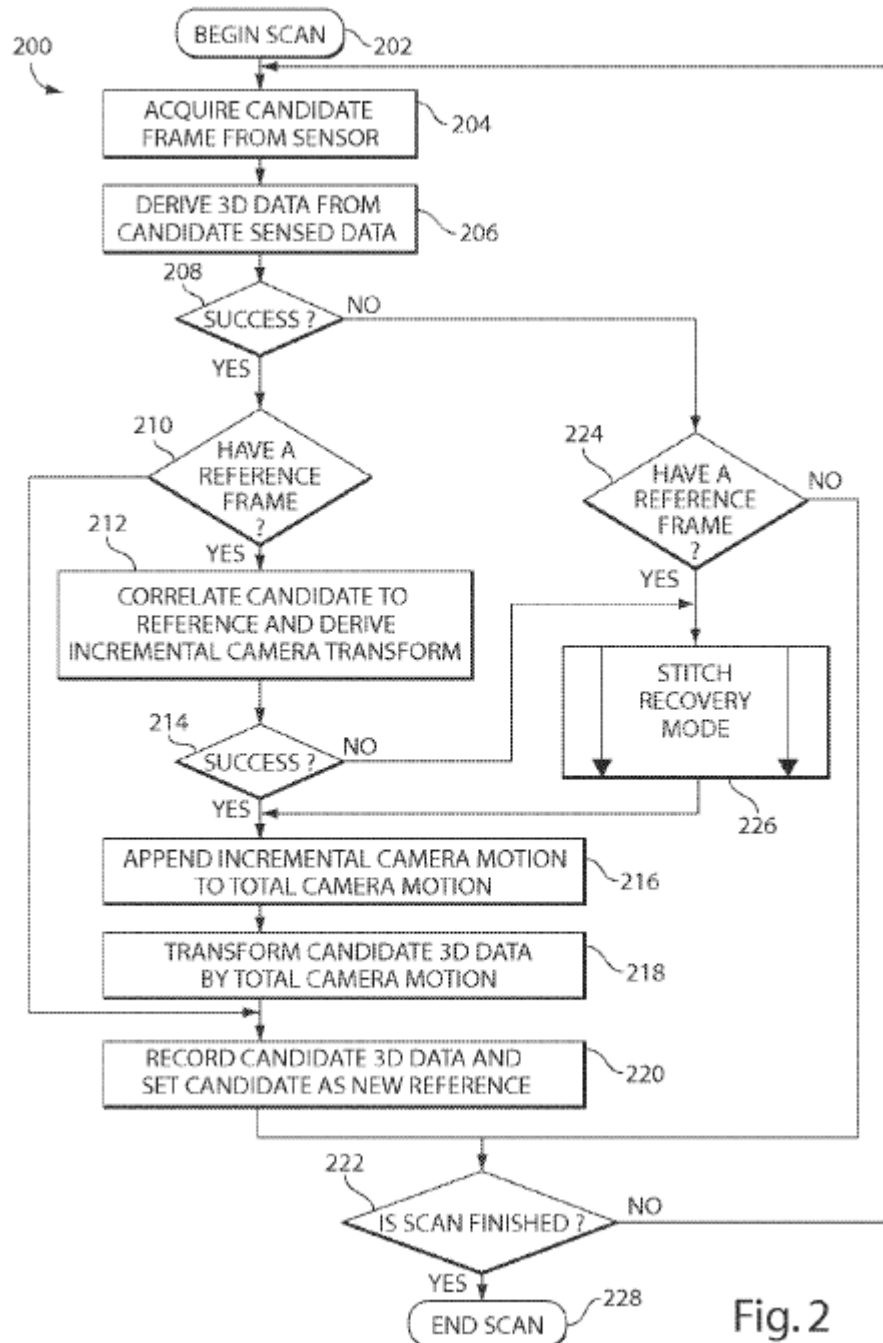


Fig. 2

Figure 2 of Kriveshko

93. In Step 206, three-dimensional data is derived from the candidate frame, e.g., two-dimensional data may be converted into three-dimensional data or a three-dimensional image. EX1005, [0061].

94. Each set of “three-dimensional data” constitutes a “three-dimensional model” at least because Kriveshko discloses that the terms “three-dimensional model” and “three-dimensional data” are “used interchangeably”, as discussed above. EX1005, [0061].

95. Kriveshko discloses that each of the first/second three-dimensional models includes “a first/second plurality of sets of three-dimensional points” as claimed. EX1005, [0008] (“incremental series of fitted three-dimensional data sets”), [0009] (“acquiring an image set for a next three-dimensional image”), [0050] (“a number of such point clouds may also be registered and combined into an aggregate point cloud constructed from images captured by a moving camera”).

96. Kriveshko discloses a “camera path” under all constructions. Concerning Petitioners’ construction requiring “physical path(s) taken by a scanner during a scan” (*see* §IX.B.), Kriveshko discloses use of a scanner that is “handheld” and “freely positionable” allowing the scanner to move along a physical path during a scan. EX1005, [0052], [0062] (“images captured by a moving camera”). *See also* EX1005, [0060] (“acquiring a candidate frame from a sensor, such as an image set

from the scanner 102 described above”), [0086] (“new frame of data may be acquired from the scanner 102”), Figure 1 (depicting freely positionable scanner 102).

97. Kriveshko discloses scanning the subject such as dentition over a “scan path”. EX1005, [0103], Figure 10 (depicting scan path 1006). Each of the initial and subsequent scans for obtaining the first and second three-dimensional models in Kriveshko are obtained over a physical path taken as the scanner is moved during a scan. EX1005, [0050] (“a number of such point clouds may also be registered and combined into an aggregate point cloud constructed from images captured by a moving camera”), [0052], [0060] (“the view will continuously shift as the user moves the scanner 102 about the subject 104”), [0103].²

² The plain and ordinary meaning of “camera path” (*i.e.*, under the District Court’s and Patent Owner’s constructions) at least encompasses Petitioner’s construction. The ’648 Patent discloses that “the camera path may correspond to a physical camera path that describes the path actually taken by a scanner during a scan, or the camera path may also or instead include a virtual camera path formed from a plurality of different physical camera paths or other virtual camera paths that intersect with one another”. EX1001, 16:38-43. *See also* EX1001, 19:23-35 (“the term virtual ... is

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98. For each model, the plurality of sets of three-dimensional points are spatially related to one another because they are all associated with data obtained during the same scan over the same (*e.g.*, physical) camera path, as noted above. Kriveshko also discloses using camera motion estimation including use of rigid transformations. *See, e.g.*, EX1005, [0070]. Thus, Kriveshko discloses that the first/second plurality of sets of three-dimensional points are “spatially related to one another by a first/second camera path” as claimed.

99. In addition, the '648 Patent does not require each “set” to be anything more than a plurality of 3D points. Thus, a “set” encompasses any grouping of points including, for example, 3D points pertaining to a specific feature such as a specific tooth or tooth surface. Kriveshko teaches scanning multiple “complex surfaces” and multiple teeth (“quadrant of teeth”, “full collection of teeth”, “two opposing arches”), and thus teaches obtaining models that each include a plurality of sets of three-dimensional points. *See, e.g.*, EX1005, [0054].

intended to distinguish models using data from multiple disparate scans” but “there may be little to distinguish a virtual stitch or a virtual stitch graph from those that are not virtual”).

100. In my opinion, Kriveshko discloses and suggests all of the requirements of Element [1.1].

2. [1.2]: obtaining a second three-dimensional model including a second plurality of sets of three-dimensional points spatially related to one another by a second camera path;

101. In my opinion, Kriveshko discloses and suggests Element [1.2] for at least the reasons discussed above concerning Element [1.1]. *See* §X.A.1.

102. Furthermore, Kriveshko discloses that “new or incremental three-dimensional data may be added to the three-dimensional model”. EX1005, [0070].

103. Kriveshko discloses registering “all of the three-dimensional data acquired during the recover mode ... to the original three-dimensional model”. EX1005, [0074].

104. Kriveshko discloses initiating a “new scan” in order to “create a supplemental three-dimensional model ... before a successful fit to the original three-dimensional model”. EX1005, [0097].

105. Each of the “new or incremental three-dimensional data”, “three-dimensional data acquired during the recover mode”, and “supplemental three-dimensional model” disclosed by Kriveshko satisfies the claimed second three-dimensional model, and the “original three-dimensional model” satisfies the first three-dimensional model. EX1005, [0097].

106. As noted above, Kriveshko discloses that the terms “three-dimensional data” and “three-dimensional image” are “used interchangeably” with “three-dimensional model”. EX1005, [0061].

107. A second three-dimensional model is also created in Kriveshko’s “stitch recover mode” (Figure 3), which is also a “disparate” data set obtained from a “disparate” scan. EX1005, [0082] (“This superposition may indicate to a user both where the scanner is currently positioned and where the scanner should be positioned in order to reacquire a scan, so that a user may manipulate the scanner to a suitable position for recovery.”), [0083] (“three-dimensional data may be derived from the new frame of data, as described for example with reference to step 206 of FIG. 2.”), [0085] (“the newly derived three-dimensional data may be test fitted to the reference frame(s) from the acquisition mode, using techniques such as those described above with reference to step 212 of FIG. 2.”), [0086] (“the test fit may be evaluated for success. If new data is successfully test fitted to the reference frame(s), the process 300 may proceed to step 320 and exit the recover mode.... When a successful test fit is made to the original (acquisition mode) three-dimensional model, the entire new three-dimensional model, or a selected portion thereof, may be registered to the original three-dimensional model using a transformation based upon the successfully fitted frames or three-dimensional images.”).

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108. Kriveshko discloses that the second three-dimensional model includes “a second plurality of sets of three-dimensional points spatially related to one another by a second camera path” for at least the reasons discussed above concerning Element [1.1]. *See* §X.A.1.

109. In my opinion, Kriveshko discloses and suggests all of the requirements of Element [1.2].

3. **[1.3]: registering one of the first plurality of sets of three-dimensional points to one of the second plurality of sets of three-dimensional points to place the first three-dimensional model and the second three-dimensional model in a shared coordinate system;**

110. In my opinion, Kriveshko discloses and suggests Element [1.3].

111. Kriveshko discloses “register[ing] new three-dimensional data to existing three-dimensional data”. EX1005, [0066].

112. Kriveshko discloses that “[a]ll such techniques that might usefully be employed to register new three-dimensional data to existing three-dimensional data” may be used. EX1005, [0066]; *see also* EX1005, [0070] (“any suitable technique for registering new three-dimensional data to existing three-dimensional data may be usefully employed in step 216, and the choice of a particular technique may vary according to the scanning technology and/or sensor data of a particular image capture system.”).

113. Kriveshko discloses that “the entire new three-dimensional model, or a selected portion thereof, may be registered to the original three-dimensional model”. EX1005, [0086] (“[w]hen a successful test fit is made to the original (acquisition mode) three-dimensional model, the entire new three-dimensional model, or a selected portion thereof, may be registered to the original three-dimensional model using a transformation based upon the successfully fitted frames or three-dimensional images.”).

114. Kriveshko teaches that registration is for the purpose of placing the first three-dimensional model and the second three-dimensional model in a shared coordinate system. EX1005, [0005] (“registration of the incremental data to a common coordinate system”). *See also* EX1005, [0006] (“the subject of the scan has also retained its position and orientation within the same global coordinate system.”).

115. Kriveshko discloses registering “one of the first plurality of sets of three-dimensional points to one of the second plurality of sets of three-dimensional points” as claimed.

116. As explained above concerning Elements [1.1]-[1.2], the first three-dimensional model includes the “first plurality of sets of three-dimensional points”

and the second three-dimensional model includes the “second plurality of sets of three-dimensional points”.

117. Kriveshko discloses registering the first and second three-dimensional models as explained above and in doing so, registers the “first plurality of sets of three-dimensional points” (which is included in the first three-dimensional model) to the “second plurality of sets of three-dimensional points” (which is included in the second three-dimensional model).

118. In my opinion, Kriveshko discloses and suggests all of the requirements of Element [1.3].

4. **[1.4]: creating a virtual stitch graph that spatially relates the first plurality of sets and the second plurality of sets, thereby providing a combined model that includes the first plurality of sets and the second plurality of sets all spatially related by the virtual stitch graph; and**

119. In my opinion, Kriveshko discloses and suggests Element [1.4]. Kriveshko discloses creating a “virtual stitch graph” under all constructions. *See* §IX.C. As discussed above with respect to Elements [1.1] to [1.3], Kriveshko discloses creating a “spatial relationship between models using data from disparate models” (Petitioners’ construction) and a “spatial relationship between data sets and/or models using data from disparate data sets and/or models” (District Court’s construction).

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120. Kriveshko discloses “testing for successful incremental fits” of data “depending upon the relationship of newly acquired data to previously acquired data.” EX1005, [0008].

121. Kriveshko discloses that “the incremental three-dimensional image data may be fitted or stitched to the existing three-dimensional model.” EX1005, [0066]. Kriveshko further discloses a “stitch recover mode” wherein the process “may attempt to reacquire or resume a scan by test fitting each newly acquired data set to some portion of the three-dimensional model”. EX1005 [0074].

122. As explained above concerning Element [1.1], Kriveshko discloses fitting and stitching using data from “disparate” models (as well as “disparate” data sets of such models).

123. According to the '648 Patent, “disparate” scans, “disparate” data sets, and “disparate” models encompass an embodiment in which a second data set or model is “obtained after a first scan is automatically or manually interrupted, or after a first scan is completed and additional data is required or desired”. EX1001, 18:47-55.

124. Kriveshko discloses fitting and stitching disparate data sets and disparate models obtained from disparate scans “where a scan is purposely interrupted by the user” as well as where scans “have been lost due to signal

degradation or scans that have been explicitly stopped through user operation”.
EX1005, [0074]. *See also* EX1005, [0059].

125. Furthermore, all three constructions of “virtual stitch graph” encompass a rigid transformation, and Kriveshko discloses creating a rigid transformation concerning the model data obtained from the initial and subsequent scans.

126. Kriveshko discloses that “new or incremental three-dimensional data may be added to the three-dimensional model” and “[i]n one embodiment using camera motion estimation, this step may include *a rigid transformation* of the incremental three-dimensional data to the coordinate system of the three-dimensional model, as depicted in step 218.” EX1005, [0070] (emphasis added). *See also* EX1005, Fig. 2 (“*transform* candidate 3D data by total camera motion”) (emphasis added).

127. A POSITA would have understood that a rigid transformation is an expression of the spatial relationship between the data sets and models (*see, e.g.*, EX1005, [0070]; EX1009, pp. 7-14; EX1008, pp. 234-236), and thus Kriveshko’s disclosure of creating a rigid transformation satisfies all constructions.

128. The “first plurality of sets of three-dimensional points” is included in the first three-dimensional model and the “second plurality of sets of three-dimensional points” is included in the second three-dimensional model.

129. As explained above, Kriveshko discloses creating a spatial relationship (such as a stitch or rigid transformation) between the first and second three-dimensional models and in doing so, creates a spatial relationship (*e.g.*, stitch or rigid transformation) between the “first plurality of sets of three-dimensional points” (which is included in the first three-dimensional model) and the “second plurality of sets of three-dimensional points” (which is included in the second three-dimensional model).

130. Further, a virtual stitch graph is created during the “recover mode” and “landing mode” which involves “stitch recovery” described in Kriveshko. *See, e.g.*, EX1005, [0059].

131. Kriveshko discloses employing such modes to address situations where “the fitting or stitch” fails. EX1005, [0059].

132. Kriveshko discloses that “[i]n the recover mode, the system 100 may seek to reacquire the previous scan by test fitting new scan data to previously acquired data.... In a related landing mode, a user may attempt to initiate a new scan registered or connected to an existing three-dimensional model.” EX1005, [0059].

133. In the recover and landing modes, a “spatial relationship” (District Court’s and 3Shape’s construction) and “a rigid transformation and/or other descriptive data” (Medit’s construction) are created between the model obtained

from the initial scan and the additional model obtained from the subsequent scan.
EX1005, [0059].

134. Kriveshko discloses that “[t]he method may include fitting each new one of the one or more additional three-dimensional images to one another to provide a second set of three-dimensional data, and upon a successful fit, adding the second set of three-dimensional data to the first set of three-dimensional data.” EX1005, [0024].

135. Kriveshko discloses that “[u]pon a successful fit, the method may further include adding the second set of three-dimensional data to the first set of three-dimensional data.” EX1005, [0031].

136. In Kriveshko, the “new or incremental three-dimensional data may be added to the three-dimensional model.” EX1005, [0070].

137. In the context of “dentistry application”, “a full three-dimensional surface scan may be obtained for two dental arches in occlusion.” EX1005, [0008].
See also EX1005, [0022].

138. Thus, Kriveshko discloses providing a combined model that includes the first plurality of sets and the second plurality of sets all spatially related by the virtual stitch graph.

139. In my opinion, Kriveshko discloses and suggests all of the requirements of Element [1.4].

5. [1.5]: refining the combined model with a global motion optimization of the virtual stitch graph.

140. In my opinion, Kriveshko in view of Zhang disclose and teach Element [1.5].

141. Patent Owner may argue that Kriveshko does not disclose Element [1.5] (*i.e.*, Patent Owner may allege that this is a difference between claim 1 and Kriveshko).

142. However, Zhang expressly discloses using “global motion optimization ... to reduce errors in the resulting three-dimensional model” and “to improve accuracy of three-dimensional reconstructions based upon camera path”. EX1006, [0045], [0022]. *See also* EX1006 (“the high-accuracy model 370 may be processed to reduce errors”), [0060].

143. Zhang discloses that global motion optimization is a “refinement” of the model. EX1006, [0011] (“three-dimensional model may be refined”), [0045] (“post-processing refinement procedure”), [0046] (“model refinement process”).

144. It would have been obvious to refine Kriveshko’s combined model using global motion optimization of the virtual stitch graph in view of Zhang for the

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purpose of, for example, reducing errors and refining the resulting three-dimensional model as taught by Zhang. EX1006, [0045]-[0046], [0011], [0022], [0060].

145. For example, Kriveshko discloses use of “a more computationally intensive post-processing step, which might yield greater accuracy and density” (EX1005, [0062]) and contemplates use of additional process steps (EX1005, [0087]), and Zhang provides such an additional step for refining the combined model.

146. Zhang discloses the same “global motion optimization” as the ’648 Patent. EX1006, [0045]. The ’648 Patent describes “global motion optimization” as follows, and Zhang contains a word-for-word identical description:

In the systems and methods described herein, a number of techniques for global motion optimization are employed to improve accuracy of three-dimensional reconstructions based upon camera path. [EX1001, 2:16-19; EX1006, [0022].]

Global motion optimization, also referred to herein as global path optimization or global camera path optimization, may be performed by a global motion optimization module 357 in order to reduce errors in the resulting three-dimensional model 358. [EX1001, 8:57-61; EX1006, [0045].]

147. Figure 3 of Zhang—which is identical to Figure 3 of the '648 Patent—depicts use of a global motion optimization module 357 which, as described above, provides means for refining and “reduc[ing] errors in the resulting three-dimensional model” (EX1006, [0045]):

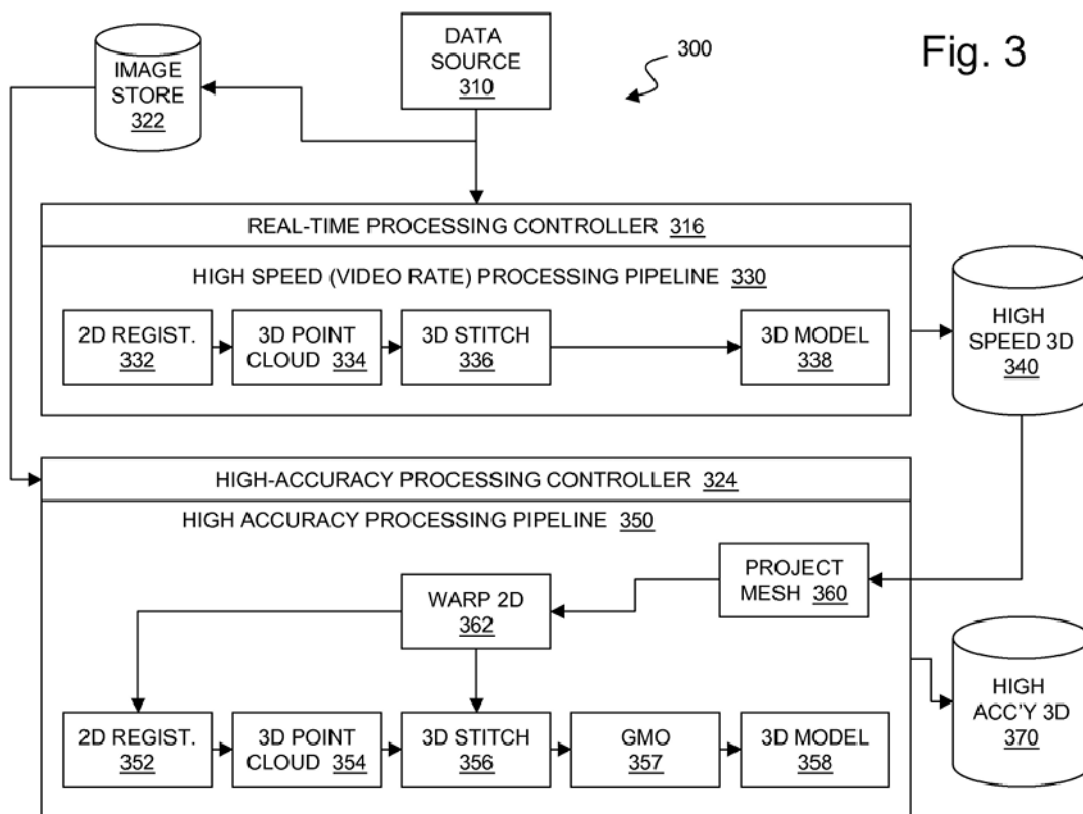


Figure 3 of Zhang

148. Zhang further discloses identical examples of global motion optimization techniques as those disclosed by the '648 Patent.

149. For example, both the '648 Patent and Zhang disclose, in identical fashion, a global motion optimization technique involving minimizing accumulation of errors along the length of the camera path by supplemental frame-to-frame motion estimation with some or all of the global path information:

In a post-processing refinement procedure, the calculation of camera path may be optimized—that is, the accumulation of errors along the length of the camera path may be minimized by supplemental frame-to-frame motion estimation with some or all of the global path information. Based on global information Such as individual frames of data in the image store 322, the high speed three-dimensional model 340, and intermediate results in the high-accuracy processing pipeline 350, the high-accuracy model 370 may be processed to reduce errors in the camera path and resulting artifacts in the reconstructed model. As a further refinement, a mesh may be projected onto the high-speed model by a mesh projection module 360. The resulting images may be warped or deformed by a warping module 362. [EX1001, 8:63-9:14; EX1006, [0045].]

150. In addition, both the '648 Patent and Zhang disclose, in identical fashion, a global motion optimization technique involving reducing errors in the

calculated camera path based upon available data for the complete camera path such as, for example, cross links that interrelate temporally distant measurements:

As shown in step 720, a numerical optimization may be performed to reduce errors in the calculated camera path based upon available data for the complete camera path such as, for example, cross links that interrelate temporally distant measurements. In general, the objective of numerical optimization is to minimize a calculated error based upon an error function for the camera path and/or reconstructed three-dimensional model. A useful formulation of the error minimization problem for a global camera path is presented below. [EX1001, 12:25-33; EX1006, [0060].]

151. Zhang teaches that its global motion optimization technique is applied to 3D stitches because global motion optimization (module 357) follows three-dimensional 3D stitching (356). *See, e.g.*, EX1006, Fig. 3.

152. In the obvious combination of Kriveshko and Zhang, the global motion optimization would be “of the virtual stitch graph” as claimed because global motion optimization would involve refining the combined model obtained from the first and second models (as taught by Kriveshko) that are spatially related by the virtual stitch graph (*e.g.*, the rigid transformation).

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153. The '648 Patent discloses that “any of the global motion optimization techniques described above” (again, which includes the same techniques disclosed by Zhang discussed above) may be suitable for performing this optimization “of the virtual stitch graph”. EX1001, 19:36-43.

154. It would have been obvious to modify Kriveshko to refine the combined model with a global motion optimization of the virtual stitch graph for several reasons. Exemplary reasons are provided below.

155. One, Zhang provides express teaching, suggestion, or motivation that would have led a person of ordinary skill in the art (“POSITA”) to modify Kriveshko to employ a global motion optimization, as discussed above. *See, e.g.*, EX1006, [0045] (“to reduce errors in the resulting three-dimensional model”), [0011], [0022], [0046], [0060].

156. Two, Kriveshko also provides such teaching, suggestion, or motivation, recognizing that there is room for improvement/refinement in its process by suggesting use of “a more computationally intensive post-processing step, which might yield greater accuracy and density” (EX1005, [0062]) and adding steps to its process (EX1005, [0087]). Zhang provides such additional steps for refining the combined model. EX1006, [0045]-[0046], [0011], [0022], [0060].

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157. Three, such a modification would have merely constituted use of a known technique (global motion optimization refinement as expressly taught by Zhang) to improve similar methods/systems (as disclosed by Kriveshko) in the same way, *e.g.*, to reduce errors in the resulting three-dimensional model as taught by Zhang.

158. Four, such a modification would have merely constituted applying a known technique (global motion optimization refinement taught by Zhang) to the known method/system of Kriveshko that is ready for improvement (see EX1005, [0062], [0087] discussed above) to yield predictable results.

159. Five, such a modification would have merely constituted combining prior art elements (the techniques/systems disclosed by Kriveshko) according to known methods (global motion optimization refinement taught by Zhang) to yield predictable results.

160. Six, such modification would have merely involved selection of Zhang's global motion optimization from a finite number of identified, predictable solutions, to improve the techniques/systems of Kriveshko with a reasonable expectation of success.

161. Such modification would have been predictable and a POSITA would have had a reasonable expectation of success—at least because Zhang discloses that

its global motion optimization is used as a process for refining a three-dimensional model like that of the combined model disclosed by Kriveshko. *See, e.g.*, EX1006, [0011] (“A three-dimensional model may be generated based upon the camera path and the data for the three-dimensional reconstruction, and the three-dimensional model may be refined based upon the optimized camera path.”), [0045] (“the high-accuracy model 370 may be processed to reduce errors in the camera path and resulting artifacts in the reconstructed model.”), [0060] (“the objective of numerical optimization is to minimize a calculated error based upon an error function for the camera path and/or reconstructed three-dimensional model”). Furthermore, as explained in §VIII.B., Kriveshko and Zhang both relate to techniques for three-dimensional image processing useful for dental applications, *i.e.*, Kriveshko and Zhang both relate to the same field of endeavor.

162. In my opinion, Kriveshko discloses and suggests all of the requirements of Element [1.5].

B. Claim 2: The method of claim 1 further comprising generating a first surface mesh of the first three-dimensional model and a second surface mesh of the second three-dimensional model.

163. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 2. *See* §X.A. (claim 1 from which claim 2 depends).

164. Kriveshko teaches generating a “sparse mesh” of the first and second three-dimensional models. EX1005, [0062].

165. Kriveshko discloses that “[r]egular rectangular grids, for example, are particularly suited to hierarchical methods using subsampling of images” and “other meshes may be used, such as triangular, square, quadrilateral, or the like, to select regularly or irregularly spaced pixels within the image set for derivation of a point cloud”. EX1005, [0062].

166. Thus, Kriveshko discloses that the “sparse mesh” is a surface mesh. EX1005, [0062]. Kriveshko also discloses use of “a three-dimensional map of interconnected polygons, such as triangles or other regular or irregular polygons” which also satisfies a “surface mesh”. EX1005, [0063]. The surface meshes are also generated when rendered/visualized. EX1005, [0076].

167. The ’648 Patent discloses that a surface mesh encompasses “polygonal surface representations” (EX1001, 18:61-66), and Kriveshko discloses various polygonal surface representations (*e.g.*, “rectangular grids”, “triangular, square, quadrilateral” meshes, “triangles or other regular or irregular polygons”) as explained above.

168. Further, Zhang discloses that “[a]s a further refinement, a mesh may be projected onto the high-speed model by a mesh projection module 360” (EX1006, [0045]).

169. The ’648 Patent provides an identical description of how the mesh is generated. EX1001, 9:7-8.

170. It would have been obvious to generate the surfaces mesh of the models as a further refinement as taught by Zhang. *See also* §VII.A.1.e. (discussing obvious reasons and reasonable expectation of success for employing Zhang’s refinements).

171. In my opinion, Kriveshko discloses and suggests the requirements of Claim 2.

C. Claim 3: The method of claim 2 wherein registering includes registering the first surface mesh to the second surface mesh, thereby providing a combined surface.

172. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 3. *See* §X.B. (claim 2 from which claim 3 depends).

173. Kriveshko discloses (i) generating first and second surface meshes of the first and second three-dimensional models (*see* claim 2), (ii) registering the second model to the first model (*see* Element [1.3]), and (iii) providing a combined model, which includes a combined surface (*see* Element [1.4]). *See also* EX1005,

abstract (“a full three-dimensional surface scan may be obtained for two dental arches”).

174. Kriveshko teaches that its processing techniques are applied to meshes. *See, e.g.*, EX1005, [0062].

175. The registering of the models taught by Kriveshko would result in registering the corresponding meshes and providing a combined surface, and it would have been obvious to register data associated with the second model to data associated with the first model (*see* Element [1.3]).

176. In my opinion, Kriveshko discloses and suggests the requirements of Claim 3.

D. Claim 4: The method of claim 3 wherein registering includes registering with an iterative closest point algorithm.

177. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 4. *See* §X.C. (claim 3 from which claim 4 depends).

178. Kriveshko discloses using “any number of quantitative techniques for comparing some or all of the newly acquired three-dimensional data to the previously acquired three-dimensional data”. EX1005, [0067].

179. Kriveshko discloses that such comparison “may be tested for success”. EX1005, [0067] (“the fit obtained in step 212, which may be considered a test fit

until accepted for addition to the previously acquired three-dimensional data, may be tested for success”).

180. One such technique contemplated by Kriveshko is iterative closest point algorithm.

181. Kriveshko discloses use of a “fitting algorithm” which involves “any number” of iterations. EX1005, [0067] (“[u]ser evaluation and feedback may also be incorporated into a fitting algorithm, which may, for example, be in response to a frequently recurring failure to fit, or to a specific failure event” and that “any number of test fits may be performed”, “where a quantitative limit or range is employed to measure a successful fit, the limit or range may be user-controlled either by explicit selection of a numeric fit parameter or by selection of a qualitative fit parameter (e.g., tight, moderate, loose, etc.)”).

182. A POSITA would have recognized that Kriveshko’s “fitting algorithm” constitutes disclosure and suggestion of using an iterative closest point algorithm. *See, e.g.*, EX1007, abstract (“The iterative closest point algorithm includes a determination of a set of points that correspond between the current depth image and

the previous depth image”)³, 7:21-26 (“the ICP algorithm is an iterative process that determines a set of corresponding points between the two depth images, determines a transformation that minimizes an error metric over the corresponding points, and repeats the process using the determined transformation until convergence is reached”). *See also* EX1008, abstract (“The iterative closest point (ICP) algorithm ... has been extensively used as optimization technique for rigid model based registration based on features extracted from medical datasets. ICP... seeks to minimize the sum of the squared distances between all points in a source and their closest points in a target model.”); EX1009, 36-37 (disclosing an “Iteratively Re-weighted Least Squares algorithm”).

183. At a minimum, it would have been obvious to employ an iterative closest point algorithm in Kriveshko’s registration process given that Kriveshko discloses that “any number of quantitative techniques for comparing some or all of the newly acquired three-dimensional data to the previously acquired three-dimensional data” may be used (EX1006, [0067]) and contemplates use of fitting algorithms.

³ I have been informed that Newcombe (EX1007), filed on January 31, 2011, constitutes prior art at least under 35 U.S.C. §102(e).

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184. As explained above, iterative closest point algorithm is a well-known technique for comparing some or all of the newly acquired three-dimensional data to the previously acquired three-dimensional data and minimizing error, and a POSITA would have recognized its suitability and advantages. EX1008, abstract (“[r]obustness against outliers is guaranteed”), EX1007 (ICP “minimizes an error metric ... until convergence is reached”). EX1007 to EX1009 disclose well known registration techniques that were available to a POSITA for implementing the techniques disclosed by Kriveshko.

185. Thus, use of ICP in Kriveshko would have been predictable, and a POSITA would have had a reasonable expectation of success, at least because Kriveshko and the references discussing ICP all relate to the same general field of endeavor, *e.g.*, techniques for three-dimensional image processing and model refinement.

186. The '648 Patent merely discloses ICP as one of several possible “suitable techniques” that can be used for three-dimensional registration of points and/or surfaces. EX1001, 18:56-61. *See also* EX1001, 21:1-5.

187. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 4.

E. Claim 5: The method of claim 3 further comprising selecting a first selected one of the first plurality of sets and a second selected one of the second plurality of sets that overlap on the combined surface.

188. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 5. *See* §X.C. (claim 3 from which claim 5 depends).

189. As explained above, Kriveshko “seek[s] to *reacquire* the previous scan by test fitting new scan data to *previously acquired data*” and “initiate a new scan registered or connected to an existing three-dimensional model”. EX1005, [0059] (emphasis added).

190. Kriveshko combines newly acquired data—for example, obtained after an interruption or completion in scanning—with previously acquired data. EX1005, [0005].

191. The “reacquisition” of data would involve use of data obtained from the scans that overlap on the combined surface, and it would have been obvious to obtain overlapping data in the reacquisition process. For example, in seeking to reacquire data of a particular surface, it would have been obvious to scan surfaces adjacent to the target surface, for example, in order to ensure that the target surface is completely scanned.

192. In addition, Kriveshko discloses selecting data based on “*spatial proximity* to the new incremental data” and that “a group of image sets or three-

dimensional data sets that are *physically closest* to the last known point on the subject may be used”. EX1005, [0068] (emphasis added). *See also* EX1005, [0010] (data selected “based upon a spatial proximity of the at least one subsequent three-dimensional image to one or more of the sequence of three-dimensional images”).

193. Given that Kriveshko discloses selecting data based on “spatial proximity” and being “physically closest” to data obtained in a previous scan, Kriveshko teaches selection of overlapping data and such selection would have been obvious.

194. Further, Kriveshko discloses use of “correlation or feature matching ... to obtain a confidence score or other objective measure of fitting” and this would also involve data that overlaps on the combined surface. EX1005, [0067].

195. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 5.

F. Claim 6: The method of claim 5 wherein at least one of the first selected one and the second selected one is a set of three-dimensional data closest to a centroid of the combined surface.

196. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 6. *See* §X.E. (claim 5 from which claim 6 depends).

197. Zhang discloses “a post-processing refinement procedure” in which “the accumulation of errors along the length of the camera path may be minimized

by supplemental frame-to-frame motion estimation with some or all of the global path information” and employs a centroid of the combined surface in such minimization. EX1006, [0045], [0011].

198. Zhang discloses minimizing error with use of “a ***centroid of common surface data*** for two or more three-dimensional reconstructions”. EX1006, [0011] (emphasis added). *See also* EX1006, page 36 (claim 40).

199. Zhang discloses storing “point cloud ***centroid*** calculations, and any other measured or calculated data to support use of the key frames in a three-dimensional reconstruction process as described herein”. EX1006, [0055] (emphasis added).

200. It would have been obvious to modify Kriveshko to select sets of three-dimensional data closest to a centroid of the combined surface as a further refinement procedure to minimize errors, as taught by Kriveshko and Zhang (*see* §X.A.1.5.).

201. A person of ordinary skill in the art would have had a reasonable expectation of success given that Kriveshko and Zhang relate to similar techniques, and Zhang teaches a refinement procedure for processing data of the type disclosed by Kriveshko (*see, e.g.,* §§VIII.B., X.A.).

202. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 6.

G. Claim 7: The method of claim 5 further comprising calculating a rigid transformation and a mean error between the first selected one and the second selected one.

203. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 7. *See* §X.E. (claim 5 from which claim 7 depends).

204. As discussed above concerning Elements [1.3]-[1.4] and Claim 5, Kriveshko discloses calculating a rigid transformation between the first selected one of the first plurality of sets and the second selected one of the second plurality of sets. *See* §§X.A.3., X.A.4., X.E.

205. Patent Owner may argue that Kriveshko does not disclose or suggest calculating a mean error.

206. However, Kriveshko discloses that “it will be appreciated that any suitable technique for registering new three-dimensional data to existing three-dimensional data may be usefully employed ... and the choice of a particular technique may vary according to the scanning technology and/or sensor data of a particular image capture system.” EX1005, [0070].

207. Use of mean error values was well known in the context of data alignment and stitching including, for example, in registration and/or usage of an iterative closest point algorithm. *See, e.g.*, EX1008, p. 235 (“the transformation that minimizes a mean square metric is computed”), pp. 235-240; EX1009, pp. 22-25.

See also EX1010, [0044]. Usage of mean error values was a common sense, well known approach to analyzing three-dimensional data.

208. Use of ICP and calculating mean error as a refinement would have been obvious for at least the reasons discussed with respect to claim 4 and Element [1.5]. *See* §§X.D., X.A.5.

209. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 7.

H. Claim 8: The method of claim 7 further comprising selecting a first neighborhood of the first plurality of sets from about the one of the first plurality of sets and a second neighborhood of the second plurality of sets from about the one of the second plurality of sets.

210. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 8. *See* §X.G. (claim 7 from which claim 8 depends).

211. Kriveshko discloses selecting a “reference frame” which can be “three-dimensional data” to assist with the “fit[ting] or stitch[ing]” of “the incremental three-dimensional image data ... to the existing three-dimensional model”. EX1005, [0065].

212. Kriveshko discloses that the “reference frames may be selected for a test fit” and “[t]he number of reference frames may be selected using various criteria”. EX1005, [0068].

213. The reference frames may be selected according to “*temporal proximity*” or “*spatial proximity*” to the new incremental data. EX1005, [0068].

214. Kriveshko also discloses that “a group of image sets or three-dimensional data sets that are *physically closest* to the last known point on the subject may be used”. EX1005, [0068].

215. In Kriveshko, the reference frame (of the first three-dimensional model) and the new incremental data (of the second three-dimensional model) are selected based on “temporal proximity”, “spatial proximity”, and/or being “physically closest to the last known point”. Thus, Kriveshko discloses selecting a first neighborhood “from about the one of the first plurality of sets” and a second neighborhood “from about the one of the second plurality of sets”.

216. Similarly, the ’648 Patent discloses that selection of some or all data sets according to proximity results in selection of a neighborhood. EX1001, 20:18-45.

217. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 8.

I. Claim 9 (Preamble): The method of claim 8 further comprising:

218. In my opinion, Kriveshko in view of Zhang discloses and suggests the preamble of Claim 9. *See* §X.H. (Claim 8 from which Claim 9 depends).

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219. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 9.

1. [9.1]: extracting a sub-region of the combined surface;

220. In my opinion, Kriveshko in view of Zhang discloses and suggests Element [9.1].

221. Kriveshko discloses that “a number of different reference frames (also referred to herein as reference images) may be selected for a test fit.” EX1005, [0068].

222. The selection of reference frame(s) constitutes extracting a part (“sub-region”) of the entirety of the combined surface.

223. Further, ICP is based on certain features “extracted” from “datasets” (EX1008, 234), and it would have been obvious to employ ICP in Kriveshko for the reasons discussed above (*see* Claim 4, §X.D.). *See also* EX1005, [0067] (use of 3D data “in whole or in part”), [0016] (processing a “portion” of 3D data). Kriveshko discloses and suggests extracting a sub-region of the combined surface at least because Kriveshko contemplates processing a “part” or “portion” of the data which represents the combined surface. *Id.*

224. In my opinion, Kriveshko in view of Zhang discloses and suggests all of the requirements of Element [9.1].

2. [9.2]: spatially relating two or more of the first plurality of sets to two or more of the second plurality of sets within the sub-region to provide a virtual stitch graph; and

225. In my opinion, Kriveshko in view of Zhang discloses Element [9.2].

226. As explained above with respect to Element [1.4], Kriveshko discloses and teaches creating a “spatial relationship” between disparate models and data sets under the District Court’s and Petitioners’ constructions of “virtual stitch graph”.
See §X.A.4.

227. For similar reasons, Kriveshko discloses “spatially relating” two or more of the first plurality of sets to two or more of the second plurality of sets.

228. Kriveshko discloses that the first three-dimensional model (*e.g.*, data obtained from an initial scan) includes two or more sets of three-dimensional points, and the second three-dimensional model (*e.g.*, new incremental data obtained from a disparate scan) includes two or more sets of three-dimensional points, as explained above. *See* §§X.A.1., X.A.2., X.A.3.

229. Kriveshko discloses “spatially relating” the first three-dimensional model to the second three-dimensional model and in doing so, spatially relates the “two or more of the first plurality of sets” of three-dimensional points (which are included in the first three-dimensional model) to the “two or more of the second

plurality of sets” of three-dimensional points (which are included in the second three-dimensional model).

230. Such spatially relating occurs within the extracted sub-region of the combined surface given that the sub-region constitutes the portion of data selected by the user.

231. A virtual stitch graph is provided for at least the reasons discussed above (*see* Element [1.5], §X.A.5).

232. In my opinion, Kriveshko in view of Zhang discloses and suggests all of the requirements of Element [9.2].

3. [9.3]: minimizing an error among spatial relationships in the virtual stitch graph, thereby providing a combined data set for the sub-region.

233. In my opinion, Kriveshko in view of Zhang discloses Element [9.3]. As discussed above, it would have been obvious to refine Kriveshko’s combined model using global motion optimization in view of Zhang (*see* Element [1.5], §X.A.5).

234. The global motion optimization disclosed by Zhang involves “minimizing an error” among spatial relationships in the virtual stitch graph between respective data of the first and second three-dimensional models. *See, e.g.*, EX1006, [0060] (“the objective of numerical optimization is to minimize a calculated error based upon an error function for the camera path and/or reconstructed three-

dimensional model.”), [0011] (“minimizing an error function for a plurality of camera positions along the camera path”).

235. Such global motion optimization results in providing combined data for the sub-region given that the sub-region is a part of the provided combined model, and given that the sub-region constitutes the portion of data selected by the user (*see* §X.A.5.).

236. In my opinion, Kriveshko in view of Zhang discloses and suggests all of the requirements of Element [9.3].

J. Claim 10: The method of claim 9 further comprising creating at least one virtual stitch between two unstitched ones of the first plurality of sets.

237. In my opinion, Kriveshko in view of Zhang discloses and suggests the subject matter of Claim 10. *See* §X.J. (Claim 9 from which Claim 10 depends).

238. Kriveshko discloses that the first three-dimensional model includes a plurality of sets of three-dimensional points (*see* Element [1.1], §X.A.1.).

239. Kriveshko discloses stitching together unstitched sets of three-dimensional points, and this involves creating a virtual stitch between unstitched data sets. EX1005, [0058] (“The three-dimensional data for each newly acquired two-dimensional image set may be derived and fitted or ‘stitched’ to existing three-dimensional data”), [0062] (“each set of three-dimensional data need not include all,

or even most, of the points that might be recovered from the candidate frame.”). *See also* EX1001, 19:32-34 (“there may be little to distinguish a ‘virtual’ stitch ... from those that are not virtual”). Further, Kriveshko discloses creating at least one virtual stitch between disparate data sets (*see* §VII.A.1.d., Element [1.4]), and performing additional stitching as necessary (*e.g.*, EX1005, Fig. 2, [0072]). Such subsequent stitching would involve creating a virtual stitch between unstitched data sets/models, *e.g.*, between both disparate and non-disparate data sets/models. *Id.*

240. As explained above, Kriveshko discloses creating a virtual stitch between both disparate and non-disparate data sets/models.

241. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 10.

K. Claim 11: The method of claim 1 further comprising refining the combined model with a deformable registration.

242. In my opinion, Kriveshko in view of Zhang discloses and suggests the subject matter of claim 11. *See* §X.A. (claim 1 from which claim 11 depends).

243. The ’648 Patent discloses that “deformable registration” encompasses the example in which stitches or steps of the camera path are “moved spatially to minimize global error.” EX1001, 19:43-47.

244. In the obvious combination, the stitches or steps of the camera path of the combined model are moved spatially as a result of the “global motion

optimization” taught by Zhang as explained above (*see* Element [1.5], §X.A.5.), *e.g.*, given that the second model is combined with the first model, and thus the combination teaches refining with a “deformable registration”. *See, e.g.*, EX1006, [0022], [0045].

245. Furthermore, Zhang discloses that “[a]s a further refinement”, the mesh “may be *warped or deformed* by a warping module 362” and “[w]arped images may be used to ease alignment and stitching between images, such as by reducing the initial error in a motion estimate.” EX1006, [0045] (emphasis added). *See also* EX1009, 39-41 (it was known to warp “target image I_1 according to the current motion estimate”).

246. It would have been obvious to employ deformable registration in Kriveshko’s process given that (i) Kriveshko discloses that “any number of quantitative techniques for comparing some or all of the newly acquired three-dimensional data to the previously acquired three-dimensional data” may be used (EX1005, [0067]), (ii) Kriveshko contemplates further refinements and steps in its process (EX1005, [0062] (use of “a more computationally intensive post-processing step, which might yield greater accuracy and density”), [0087]), and (iii) deformable registration was a well-known technique for data refinement, comparing some or all

of the newly acquired three-dimensional data to the previously acquired three-dimensional data, and minimizing error (EX1006, [0045]; EX1009, 39-41).

247. A POSITA would have had a reasonable expectation of success given that Kriveshko and Zhang relate to similar techniques and are from the same field of endeavor (*see, e.g.*, §VIII.B.), and Zhang teaches a refinement procedure for processing data of the type disclosed by Kriveshko (*see, e.g.*, §X.A.5.).

248. In my opinion, Kriveshko in view of Zhang discloses and suggests all of the requirements of Claim 11.

L. Claim 12 (Preamble): A computer program product comprising computer executable code embodied on a non-transitory computer readable medium that, when executing on one or more computing devices, performs the steps of:

249. In my opinion, Kriveshko discloses and suggests the preamble of Claim 12 for at least the reasons discussed above with respect to the preamble of Claim 1. *See* §X.A.

250. Further, Kriveshko discloses that the “computer program product disclosed herein may include computer executable code which may be embodied on a computer readable medium that, when executing on one or more computing devices, performs the steps” of the processes described in Kriveshko. EX1005, [0027]. *See also* EX1005, [0028], [0029], [0034], [0035], [0088]. A POSITA would have understood that Kriveshko’s computer readable medium is non-transitory given

that its purpose is to store the computer program product and code. Further, Kriveshko discloses an image capture system 100 including 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. EX1005, Fig. 1, [0051], [0056] (memory and hard drive are non-transitory).

1. [12.1]: obtaining a first three-dimensional model including a first plurality of sets of three-dimensional points spatially related to one another by a first camera path;

251. In my opinion, Kriveshko discloses and suggests Element [12.1] for at least the same reasons as Element [1.1]. *See* §X.A.1.

252. In my opinion, Kriveshko discloses and suggests all of the requirements of Element [12.1].

2. [12.2]: obtaining a second three-dimensional model including a second plurality of sets of three-dimensional points spatially related to one another by a second camera path;

253. In my opinion, Kriveshko discloses and suggests Element [12.2] for at least the same reasons as Element [1.2]. *See* §X.A.2.

3. **[12.3]: registering one of the first plurality of sets of three-dimensional points to one of the second plurality of sets of three-dimensional points to place the first three-dimensional model and the second three-dimensional model in a shared coordinate system;**

254. In my opinion, Kriveshko discloses and suggests Element [12.3] for at least the same reasons as Element [1.3]. *See* §X.A.3.

4. **[12.4]: creating a virtual stitch graph that spatially relates the first plurality of sets and the second plurality of sets, thereby providing a combined model that includes the first plurality of sets and the second plurality of sets all spatially related by the virtual stitch graph; and**

255. In my opinion, Kriveshko discloses and suggests Element [12.4] for at least the same reasons as Element [1.4]. *See* §X.A.4.

5. **[12.5]: refining the combined model with a global motion optimization of the virtual stitch graph.**

256. Kriveshko in view of Zhang disclose and teach Element [12.5] for at least the same reasons as Element [1.5]. *See* §X.A.5.

M.Claim 13: The computer program product of claim 12 further comprising code that performs the step of generating a first surface mesh of the first three-dimensional model and a second surface mesh of the second three-dimensional model.

257. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 13 for at least the same reasons discussed above with respect to claim 2. *See* §§X.B. (claim 2) and X.L. (claim 12).

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258. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

259. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 13.

N. Claim 14: The computer program product of claim 13 wherein registering includes registering the first surface mesh to the second surface mesh, thereby providing a combined surface.

260. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 14 for at least the same reasons discussed above with respect to claim 3. *See* §X.C. (claim 3) and §X.M. (claim 13).

261. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

262. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 14.

O. Claim 15: The computer program product of claim 14 wherein registering includes registering with an iterative closest point algorithm.

263. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 15 for at least the same reasons discussed above with respect to claim 4. *See* §X.D. (claim 4) and §X.N. (claim 14).

264. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

265. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 15.

P. Claim 16: The computer program product of claim 14 further comprising code that performs the step of selecting a first selected one of the first plurality of sets and a second selected one of the second plurality of sets that overlap on the combined surface.

266. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 16 for at least the same reasons discussed above with respect to claim 5. *See* §X.E. (claim 5) and §X.N. (claim 14).

267. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

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268. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 16.

Q. Claim 17: The computer program product of claim 16 wherein at least one of the first selected one and the second selected one is a set of three-dimensional data closest to a centroid of the combined surface.

269. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 17 for at least the same reasons discussed above with respect to claim 6. *See* §X.F. (claim 6) and §X.P. (claim 16).

270. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

271. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 17.

R. Claim 18: The computer program product of claim 16 further comprising code that performs the step of calculating a rigid transformation and a mean error between the first selected one and the second selected one.

272. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of Claim 18 for at least the same reasons discussed above with respect to Claim 7. *See* §X.G. (claim 7) and §X.P. (claim 16).

273. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

274. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 18.

S. Claim 19: The computer program product of claim 18 further comprising code that performs the step of selecting a first neighborhood of the first plurality of sets from about the one of the first plurality of sets and a second neighborhood of the second plurality of sets from about the one of the second plurality of sets.

275. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of claim 19 for at least the same reasons discussed above with respect to claim 8. *See* §X.H. (claim 8) and §X.R. (claim 18).

276. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

277. In my opinion, Kriveshko discloses and suggests all of the requirements of Claim 19.

T. Claim 20 (Preamble): The computer program product of claim 19 further comprising code that performs the steps of:

278. In my opinion, Kriveshko discloses and suggests the subject matter of the preamble of Claim 20 for at least the same reasons discussed above with respect to the preamble of claim 9. *See* §X.I.

279. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

1. [20.1]: extracting a sub-region of the combined surface;

280. In my opinion, Kriveshko in view of Zhang disclose and teach the subject matter of Element [20.1] for at least the same reasons discussed above with respect to Element [9.1]. *See* §X.I.1.

2. [20.2]: spatially relating two or more of the first plurality of sets to two or more of the second plurality of sets within the sub-region to provide a virtual stitch graph; and

281. In my opinion, Kriveshko in view of Zhang disclose and teach the subject matter of Element [20.2] for at least the same reasons discussed above with respect to Element [9.2]. *See* §X.I.2.

3. [20.3]: minimizing an error among spatial relationships in the virtual stitch graph, thereby providing a combined data set for the sub-region.

282. In my opinion, Kriveshko in view of Zhang disclose and teach the subject matter of Element [20.3] for at least the same reasons discussed above with respect to Element [9.3]. *See* §X.I.3.

U. Claim 21: The computer program product of claim 20 further comprising code that performs the step of creating at least one virtual stitch between two unstitched ones of the first plurality of sets.

283. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of Claim 21 for at least the same reasons discussed above with respect to Claim 10. *See* §X.J. (claim 10) and §X.T. (claim 20).

284. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

285. In my opinion, Kriveshko in view of Zhang discloses and suggests all of the requirements of Claim 21.

V. Claim 22: The computer program product of claim 12 further comprising code that performs the step of refining the combined model with a deformable registration.

286. In my opinion, Kriveshko in view of Zhang disclose and suggest the subject matter of Claim 22 for at least the same reasons discussed above with respect to Claim 11. *See* §X.K. (claim 11) and §X.L. (claim 12).

287. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

288. In my opinion, Kriveshko in view of Zhang discloses and suggests all of the requirements of Claim 22.

W.Claim 23 (Preamble): A system comprising:

289. In my opinion, Kriveshko discloses and suggests the subject matter of the preamble of Claim 23 for at least the same reasons discussed above with respect to the preambles of Claims 1 and 12. *See* §X.A. (claim 1) and §X.L. (claim 12).

290. Kriveshko discloses “[a] scanning system that acquires three-dimensional images as an incremental series of fitted three-dimensional data sets is improved by testing for successful incremental fits in real time and providing a variety of visual user cues and process modifications depending upon the relationship of newly acquired data to previously acquired data.” EX1005, abstract.

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291. Kriveshko discloses an image capture system 100 including 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. EX1005, [0051].

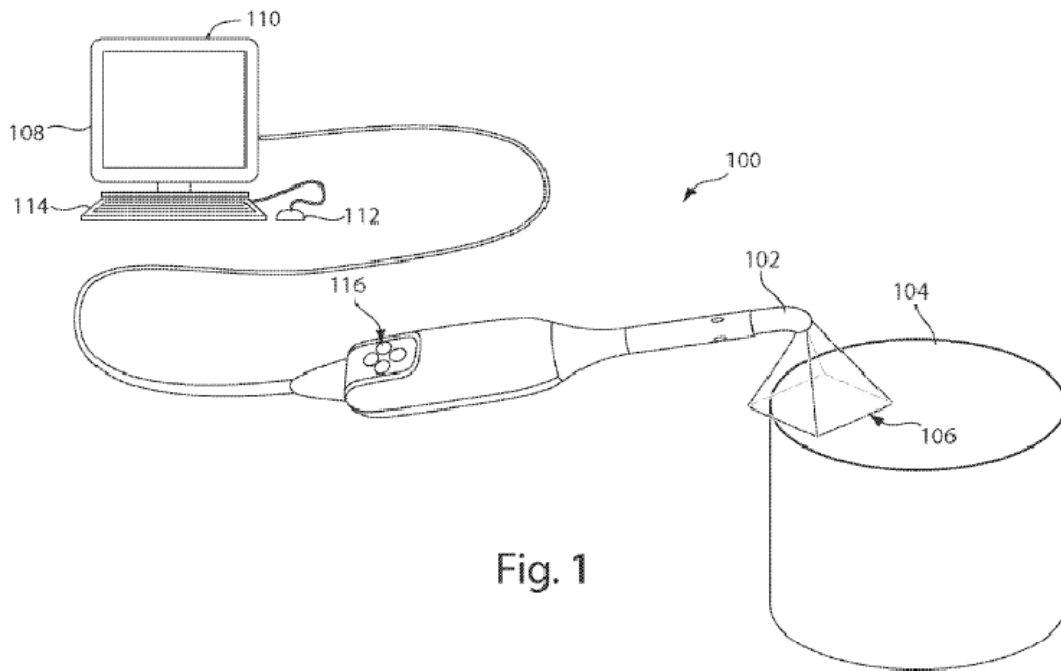


Fig. 1

Figure 1 of Kriveshko

292. As noted above, Kriveshko employs a “computer program product” including “computer executable code” for performing its processes. EX1005, [0027]-[0029], [0034]-[0035], [0088].

1. [23.1]: a scanner configured to obtain a first three-dimensional model including a first plurality of sets of three-dimensional points spatially related to one another by a first camera path and

293. In my opinion, Kriveshko discloses and suggests Element [23.1] for at least the same reasons as Elements [1.1] and [12.1]. *See* §§X.A.1., X.L.1.

294. Kriveshko discloses that the system “may include a scanning device that acquires three-dimensional surface data from a subject as a sequence of three-dimensional images, each one of the sequence of three-dimensional images fitted to at least one previous one of the sequence of three-dimensional images.” EX1005, [0013].

295. Kriveshko discloses that first and second three-dimensional models and data associated therewith are obtained by a scanner. EX1005, [0060] (“The process 200 may begin 202 by acquiring a candidate frame from a sensor, such as an image set from the scanner 102 described above”), [0086] (“new frame of data may be acquired from the scanner 102. At this point, the newly derived three-dimensional data may be fitted to three-dimensional data previously derived in the recover mode.”), Figure 1 (scanner 102).

296. In my opinion, Kriveshko discloses and suggests all of the requirements of Element [23.1].

2. **[23.2]: a second three-dimensional model including a second plurality of sets of three-dimensional points spatially related with one another by a second camera path;**

297. In my opinion, Kriveshko discloses and suggests Element [23.2] for at least the same reasons as Elements [1.2], [12.2], and [23.1]. *See* §§X.A.2., X.L.2., X.W.1.

3. **[23.3]: a processor and memory configured to register one of the first plurality of sets of three-dimensional points to one of the second plurality of sets of three-dimensional points to place the first three-dimensional model and the second three-dimensional model in a shared coordinate system,**

298. In my opinion, Kriveshko discloses and suggests Element [23.3] for at least the same reasons as Elements [1.3] and [12.3]. *See* §§X.A.3., X.L.3.

299. Further, Kriveshko discloses a processor and memory used to perform the various processes disclosed therein. EX1005, [0056] (“The computer 108 may be, for example, a personal computer or other processing device. In one embodiment, the computer 108 includes a personal computer with a dual 2.8 GHz Opteron central processing unit, 2 gigabytes of random access memory, a TYAN Thunder K8WE motherboard, and a 250 gigabyte, 10,000 rpm hard drive.”). *See also* EX1005, [0088].

300. In my opinion, Kriveshko discloses and suggests all of the requirements of Element [23.3].

4. **[23.4]: to create a virtual stitch graph that spatially relates the first plurality of sets and the second plurality of sets, thereby providing a combined model that includes the first plurality of sets and the second plurality of sets all spatially related by the virtual stitch graph, and**

301. In my opinion, Kriveshko discloses and suggests Element [23.4] for at least the same reasons as Elements [1.4], [12.4], and [23.3] (Kriveshko discloses a processor and memory). *See* §§X.A.4., X.L.4., X.W.3.

5. **[23.5]: to refine the combined model with a global motion optimization of the virtual stitch graph; and**

302. In my opinion, Kriveshko in view of Zhang disclose and teach Element [23.5] for at least the same reasons as Elements [1.5], [12.5] , and [23.3] (Kriveshko discloses a processor and memory). *See* §§ X.A.5., X.L.5., X.W.3. *See also* EX1006, [0045], Fig. 3.

6. **[23.6]: a display configured to render the combined model.**

303. In my opinion, Kriveshko in view of Zhang disclose and suggest Element [23.6]. Kriveshko's system includes a display 110, for example, as depicted in Figure 1. EX1005, [0051].

304. Kriveshko discloses that the display is configured to render the combined model. EX1005, [0093] ("Over a number of successive acquisitions and fits, a large three-dimensional model may be acquired, and the aggregate point cloud may be rendered with shading to simulate a three-dimensional view of the point

cloud”). *See also* EX1005, [0062] (“relatively sparse subset of pixel data may be employed for real time rendering and feedback”), [0076] (“visual cues or indicators may be provided to a user through the monitor 110 with respect to whether the image capture system 100 is in a recover mode or a normal acquisition mode.... The computer may render the three-dimensional model, which may be a three-dimensional point cloud of surface data acquired for the subject 104”)., [0013]-[0014].

305. In my opinion, Kriveshko discloses and suggests all of the requirements of Element [23.6].

X. Claim 24 (Preamble): A system comprising:

306. In my opinion, Kriveshko discloses and suggests the subject matter of the preamble of Claim 24 for at least the same reasons discussed above with respect to the preamble of claim 23. *See* §X.W.

1. [24.1]: scanning means for obtaining a first three-dimensional model including a first plurality of sets of three-dimensional points spatially related to one another by a first camera path and

307. In my opinion, Kriveshko discloses and suggests Element [24.1] for at least the same reasons as Element [23.1]. *See* §X.W.1.

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308. As explained above in §IX.D., the District Court and parties did not construe the term “scanning means” as a means-plus-function term under Section 112(f)/112(6) in the Related Litigation.

309. Nonetheless, Kriveshko discloses “scanning means” under such an interpretation. Kriveshko discloses performing the function of scanning for obtaining a first three-dimensional model including a first plurality of sets of three-dimensional points spatially related to one another by a first camera path, and a second three-dimensional model including a second plurality of sets of three-dimensional points spatially related to one another by a second camera path. *See, e.g.*, Elements [1.1]-[1.2] above. Kriveshko discloses structure for performing this function, *e.g.*, a scanner that captures images from a surface of an object (EX1005, [0051], [0063]); a camera or camera system suitable for capturing images from which a three-dimensional point cloud or other three-dimensional data may be recovered (EX1005, [0052], [0063]); and 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 such as starting and stopping scans (EX1005, [0052]). *See also* §X.W.1.

310. In my opinion, Kriveshko discloses and suggests Element [24.1] under any construction.

2. **[24.2]: a second three-dimensional model including a second plurality of sets of three-dimensional points spatially related with one another by a second camera path; and**

311. In my opinion, Kriveshko discloses and suggests Element [24.2] for at least the same reasons as Element [23.2]. *See* § X.W.2.

312. In my opinion, Kriveshko discloses and suggests “scanning means” under any construction as explained above.

3. **[24.3]: processing means for registering one of the first plurality of sets of three-dimensional points to one of the second plurality of sets of three-dimensional points to place the first three-dimensional model and the second three-dimensional model in a shared coordinate system,**

313. In my opinion, Kriveshko in view of Zhang discloses and suggests Element [24.3] for at least the same reasons as Element [23.3]. *See* §X.W.3.

314. As explained above in §IX.D., the District Court and parties did not construe the term “processing means” as a means-plus-function term under Section 112(f)/112(6) in the Related Litigation.

315. Nonetheless, Kriveshko-Zhang discloses “processing means” under such an interpretation. Kriveshko-Zhang discloses performing the function of registering one of the first plurality of sets of three-dimensional points to one of the second plurality of sets of three-dimensional points to place the first three-dimensional model and the second three-dimensional model in a shared coordinate

system, creating a virtual stitch graph that spatially relates the first plurality of sets and the second plurality of sets, thereby providing a combined model that includes the first plurality of sets and the second plurality of sets all spatially related by the virtual stitch graph, and refining the combined model with a global motion optimization of the virtual stitch graph. *See, e.g.*, Elements [1.3]-[1.5] above. Kriveshko discloses structure for performing this function, *e.g.*, a personal computer or other processing device (EX1005, [0056]); one or more microprocessors, microcontrollers, embedded microcontrollers, programmable digital signal processors or other programmable devices, along with internal and/or external memory (EX1005, [0088]); and an application specific integrated circuit, a programmable gate array, programmable array logic, or any other device that may be configured to process electronic signals (EX1005, [0088]).

316. In my opinion, Kriveshko-Zhang discloses and suggests Element [24.3] under any construction.

4. **[24.4]: creating a virtual stitch graph that spatially relates the first plurality of sets and the second plurality of sets, thereby providing a combined model that includes the first plurality of sets and the second plurality of sets all spatially related by the virtual stitch graph, and**

317. In my opinion, Kriveshko in view of Zhang discloses and suggests Element [24.4] for at least the same reasons as Element [23.4]. *See* §X.W.4.

318. In my opinion, Kriveshko-Zhang discloses and suggests “processing means” under any construction as explained above.

5. [24.5]: refining the combined model with a global motion optimization of the virtual stitch graph.

319. In my opinion, Kriveshko in view of Zhang disclose and teach Element [24.5] for at least the same reasons as Element [23.5]. *See* §X.W.5. *See also* EX1006, [0045], Fig. 3.

320. In my opinion, Kriveshko-Zhang discloses and suggests “processing means” under any construction as explained above.

XI. CLAIMS 4 AND 7 WOULD HAVE BEEN OBVIOUS OVER KRIVESHKO IN VIEW OF ZHANG, FURTHER IN VIEW OF ESTÉPAR AND SZELISKI (GROUND 2).

321. In my opinion, Claims 4 and 7 of the ’648 Patent are unpatentable over the prior art asserted in Ground 2.

322. Patent Owner may argue that the subject matter of dependent claims 4 and 7 would not have been obvious over Kriveshko and Zhang. Any such argument is untenable for the reasons discussed above. As explained above, the subject matter of claims 4 and 7 would have been obvious over Kriveshko-Zhang as evidenced by Estépar and Szeliski. *See* §§X.D., X.G.

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323. Further, each of Estépar and Szeliski disclose, suggest and teach the subject matter of claims 4 and 7 for the reasons discussed above in Ground 1. *See* §§X.D., X.G.

324. In my opinion, A POSITA would have had reason to combine Kriveshko-Zhang with each of Estépar and Szeliski with a reasonable expectation of success to arrive at the subject matter of claims 4 and 7 for the reasons discussed above. *See* §§X.D., X.G.

325. For example, Kriveshko discloses use of a “fitting algorithm” and “any number of quantitative techniques” (EX1005, [0067]), and Estépar and Szeliski disclose one such well-known technique with recognized advantages—ICP. *See also* EX1007, abstract (discussed above).

326. Use of ICP in Kriveshko-Zhang would have been predictable, and a POSITA would have had a reasonable expectation of success, at least because Kriveshko-Zhang and the references discussing ICP all relate to the same general field of endeavor, *e.g.*, techniques for three-dimensional image processing and model refinement.

327. Claims 4 and 7 would have been obvious for a number of additional reasons. One, such a modification would have merely constituted use of known techniques (ICP, calculating a rigid transformation and mean error) to improve

similar methods/systems (as disclosed by Kriveshko-Zhang) in the same way, *e.g.*, to reduce errors in the resulting three-dimensional model as taught by Zhang. Two, such a modification would have merely constituted applying known techniques (ICP, calculating a rigid transformation and mean error) to the known method/system of Kriveshko-Zhang that is ready for improvement to yield predictable results. Three, such a modification would have merely constituted combining prior art elements (the techniques/systems disclosed by Kriveshko-Zhang) according to known methods (ICP, calculating a rigid transformation and mean error) to yield predictable results. Four, such modification would have merely involved selection of ICP and calculation of a rigid transformation and mean error from a finite number of identified, predictable solutions, to improve the techniques/systems of Kriveshko-Zhang with a reasonable expectation of success.

XII. ANY PURPORTED SECONDARY CONSIDERATIONS EVIDENCE DOES NOT OVERCOME THE STRONG EVIDENCE OF THE OBVIOUSNESS OF THE CLAIMS

328. I am currently unaware of any secondary considerations evidence that may be commensurate with the challenged claims of the '648 Patent.

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XIII. CONCLUSION

329. For the reasons set forth above, it is my opinion that all elements of Claims 1-24 of the '648 Patent are disclosed or suggested by the prior art. In my opinion, Claims 1-24 of the '648 Patent would have been anticipated or rendered obvious by the prior art.

330. In signing this Declaration, I understand that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

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

Date: August 12, 2024



Eli Saber

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APPENDIX A

I have previously testified and/or been consulted as an expert in the
following matters:

Maxell, LTD. v. TCL Electronics Holdings Ltd. Et. al.

June 2024 – Present

Case 5:23-CV-00108-RSW-JBB (EDTX) and related proceedings including
against LG Electronics and Samsung

- Legal Firm: Mayer-Brown
- Retained as an expert on behalf of Maxell
- Provide expert opinions in support of legal proceedings.

3Shape A/S (Petitioner) v. Medit Corporation

Jan. 2024 – Present

US Patent and Trademark Office, Patent Trial and Appeal Board

- Legal Firm: Buchanan, Ingersoll and Rooney PC
- Retained as an expert on behalf of 3Shape A/S to provide expert opinions for multiple inter partes proceedings involving U.S. Patent US 10,076,391 (IPR2024-00548), US 11,234,798 (IPR2024-00549), US 9,191,648, US 9,262,864, US 7,912,257 and US 9,245,374.

3Shape A/S (Petitioner) v. Dental Imaging Technologies & Carestream Dental

Jan. 2024 – Present

US Patent and Trademark Office, Patent Trial and Appeal Board

- Legal Firm: Buchanan, Ingersoll and Rooney PC
- Retained as an expert on behalf of 3Shape A/S to provide expert opinions on inter partes proceedings involving U.S. Patent US 10,076,391 (IPR2024-00548), US 11,234,798 (IPR2024-00549) and US 9,191,648

Amazon v. Nokia

Jan. 2024 – Present

- Legal Firm: Perkins-Coie
- Retained as an expert on behalf of Amazon (Petitioner)

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- Provided expert opinions and a declaration in support of US 7,724,818 (IPR2024-00572)
- Provide expert opinions and a declaration for an IPR proceeding re. US 6,856,701
- Provide expert opinions and a declaration for an IPR proceeding re. US 8,175,148
- Provide expert reports with regards to invalidity, non infringement and domestic industry with regards to ITC case No. 337-TA-1380
- Provided a Deposition on June 28st, 2024 for ITC case No. 337-TA-1380.

Autonomous Devices LLC v. Tesla, Inc

October 2022 - Present

US District Court, District of Delaware, case No.

- Legal Firm: McKool-Smith
- Retained as an expert by the Barr Group on behalf of Autonomous Devices.
- Provided declarations in support of legal proceedings.
- Working on multiple IPRs (5X): IPR2023-01054, IPR2023-01055, IPR2023-01169, IPR2023-01172, IPR2023-01173.
- Provided or in process of providing multiple declarations in support of Patent Owner Response and Motion to Amend with regards to the above IPRs
- Provided a Deposition on May 16th, 2024 with regards to IPR 2023-01054.
- Provided a Deposition on May 21th, 2024 with regards to IPR 2023-01055.
- Provided a Deposition on June 14th, 2024 with regards to IPR 2023-01169.
- Provided a Deposition on June 21st, 2024 with regards to IPR2023-01172 and IPR 2023-01173.

Medit USA, Crown Jade Co. Ltd. (Petitioner) v. 3Shape A/S (Patent Owner)

Oct. 2023 – Present

US Patent and Trademark Office, Patent Trial and Appeal Board

- Legal Firm: Buchanan, Ingersoll and Rooney PC

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- Retained as an expert on behalf of 3Shape A/S to provide expert opinions on IPR proceedings involving U.S. Patent Nos. 10,695,151; 11,076,146; 11,368,667.
- Provide expert opinions in support of Patent Owner Response.
- Institution was denied for 11,076,146; 11,368,667.
- Institution granted for U.S. 10,695,151 (IPR2023-01315)
- Provided a declaration in support of Patent Owner regarding US 10,695,151 (IPR2023-01315)
- Provided a Deposition on August 8th, 2024 for IPR2023-01315.

Meta Platforms, Inc.; Instagram, Inc.; WhattsAPP LLC; Meta Platforms Technologies, LLC; and Giphy, Inc. (Petitioners) v. VL Collective IP LLC (Patent Owner)

Jan. 2024 – Present

- Legal Firm: Reichman Jorgensen Lehman & Feldberg LLP
- Retained as an expert on behalf of VL Collective IP LLC
- Provided expert opinions and a declaration in support of Patent Owner Response with regards to IPR2023-00924.
- Provided a Deposition on May 30th, 2024 with regards to IPR 2023-00924.

Facetec, Inc. v. iProov Ltd., Case No. 2:21-cv-02252-ART-BNW

October 2022 - Present

US District Court, District of Nevada

- Legal Firm: OneLLP
- Retained as an expert by Teklicon on behalf of FaceTec, Inc.
- Provided expert opinions as needed in support of legal proceedings

TVISION INSIGHTS v. The NIELSEN Company (US), LLC

August 2023 - Present

US Patent and Trademark Office, Patent Trial and Appeal Board

- Legal Firm: Erise Intellectual Property Law
- Retained as an expert on behalf of the Nielsen Company (US), LLC
- Provided expert opinions and a declaration in support of patent owner in IPR2023-01014. Documents were filed on 10/11/2023.

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

- PTAB decision to institute was reached January 2024.
- Provided a Deposition on July 2nd, 2024.

In Re Lyft Rideshare Litigation

Dec. 2021 – Present

Superior Court of the State of California, Case No. CJC-20-005061

- Legal Firm: Williams & Connolly, LLP
- Retained as an expert by WIT Legal, LLC on behalf of Lyft (Defendant)
- Provide reports and consulting services on the challenges of the use of Dashcam solutions in Vehicles
- Provided a Deposition on March 24th, 2023.
- The first portion of the Case that requires my expertise has been settled.

RealD, LLC v. Microsoft Corp., NO. 2:22-cv-00942-TL

Feb. 2023 – June 2024

- Legal Firm: Michelman & Robinson
- Retained as an expert on behalf of RealD, LLC
- Provided expert opinions and a declaration in support of IPR2023-01046. Patent Owner Preliminary Response filed on 10/13/2023.
- Provide expert opinions and additional reports in support of Federal case.
- Provide algorithm support for software review.
- Provided expert opinions and a declaration in support of Patent Owner Response with regards to IPR2023-01046. POR filed on March 15th, 2024
- Provided a Deposition on June 5th and 7th, 2024 with regards to IPR 2023-01046.

Meta Platforms, Inc. f/k/a Facebook, Inc. v. Angel Technologies Group LLC

May 2023 – October 2023

US District Court, District of Nevada

- Legal Firm: McKool-Smith
- Retained as an expert by Alliance Technical Staffing on behalf of Angel Technologies Group LLC.
- Provide expert opinions and declarations in support of four IPR proceedings (IPR2023-00057, IPR2023-00058, IPR2023-00059, IPR2023-00060).

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

- Provided a Deposition on October 20th, 2023 for IPR2023-00057, IPR2023-00058 and IPR2023-00059
- Provided a Deposition on October 23rd, 2023 for IPR2023-00060.

Alarm.com Incorporated v. Vivint, Inc NO. 2:23-CV-00004-JRG-RSP

March 2023 – Dec. 2023

- Legal Firm: Cravath, Swaine and Moore, LLP
- Retained as an expert on behalf of Alarm.com, Inc.
- Case has been settled

HL Holdings, Inc. v. LNHL, LLC, et al.

July 2023 – Dec. 2023

- Legal Firm: Nelson, Mullins, Riley and Scarborough LLP
- Retained as an expert by IMS Consulting and Expert Services on behalf of LNHL, LLC and Seek Now Inc. f/k/a Ladder Now LLC.
- Provided expert opinions and a report in support of legal proceedings.
- Provided a Deposition on November 29th, 2023
- Case has been settled.

Angel Group Co. Ltd. V. Sensen Networks Group Pty Ltd

July 2023 – Oct. 2023

- Legal Firm: Norton Rose Fulbright
- Retained as an expert on behalf of Angel Group Co. Ltd.
- Provide expert opinions in support of a potential IPR proceeding.
- Case has been settled.

United Services Automobile Association v. Truist Bank

March 2023 – Oct. 2023

- Case No. 2-22-CV-00291
- Legal Firm: Cravath, Swaine and Moore, LLP
- Retained as an expert on behalf of Truist Bank.
- Performed review of six patents.
- Case was settled.

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

Dental Imaging Technologies Corp. (Petitioner) v. 3Shape A/S (Patent Owner)

Feb. 2023 – July 2023

US Patent and Trademark Office, Patent Trial and Appeal Board

- Legal Firm: Buchanan, Ingersoll and Rooney PC
- Retained as an expert on behalf of 3Shape A/S.
- Provided consulting services in support of POPR for IPR2023-00387 (US 11,076,146).
- Provided consulting services in support of POPR for IPR2023-00400 (US 10,695,151).
- Provided consulting services in support of POPR for IPR2023-00411 (US 11,368,667).
- PTAB decision to NOT Institute on all three IPRs.

Nike v. Valmarc

January 2023 – Present

- Legal Firm: Hilgers Graben
- Retained as an expert on behalf of Valmarc Corporation
- Provided expert opinions in support of Patent Owner Preliminary Response on petitions IPR2022-01403 & IPR2022-01404
- PTAB granted institution but client opted not to pursue defending the patents.

Sensormatic Electronics, LLC v. Genetec, Inc. et al.

Oct. 2021 – Feb. 2023

US District Court, District of Delaware, Case 1:20-cv-00760-MN

- Legal Firm: Fish & Richardson, P.C.
- Retained as an expert by IMS Expert Services on behalf of Genetec, Inc. et al. (Defendant)
- Representing Genetec (USA) Inc. and Genetec Inc. (C. A. No. 20-760)
- Provided Opening, Rebuttal and Reply reports regarding invalidity & Non-infringement with regards to US 7,307,652.
- Sat in on a deposition of Plaintiff expert (April 29th, 2022) per counsel request.

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

- Provided a deposition on May 3rd, 2022
- Case is completed.

Roku, Inc. v. Flexiworld Technologies, Inc.

June 2022 – October 2022

US Patent and Trademark Office, Patent Trial and Appeal Board, Case No. IPR2022-01112

US Patent and Trademark Office, Patent Trial and Appeal Board, Case No. IPR2022-001269

- Legal Firm: Perkins-Coie, LLP
- Retained as an expert by WIT Legal, LLC on behalf of Roku (Petitioner).
- Provided a declaration in June 2022 in support of the IPR petition for US 10,140,073.
- Provided a declaration in July 2022 in support of the IPR petition for US 7,944,577.
- Case was settled in October 2022.

CareView Communications, Inc. v. Interactive Digital Solutions, Inc.

Jan. 2022 – April 2022

- Legal Firm: Mintz, Levin, Cohn, Ferris, Glovsky & Popeo, P. C.
- Retained as an expert by IMS Expert Services on behalf of Interactive Digital Solutions, LLC (Defendant) to provide declarations in support of 3 IPR proceedings
- Case was settled in April 2022.

Sovereign Peak Ventures, LLC v. Hisense Co., LTD

Nov. 2021 – Dec. 2021

US District Court, Eastern District of Texas, Case No. 21-cv-00209

- Legal Firm: Perkins-Coie, LLP
- Retained as an expert by WIT Legal, LLC on behalf of Hisense Co. (Defendant).
- Working to provide a declaration in support of the IPR petition for US 8,019,169.
- Case was settled in Early 2022.

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

Perfect Corporation v. Lennon Image Technologies, LLC

Sept. 2021 – June 2022

US Patent and Trademark Office, Patent Trial and Appeal Board, IPR2021-00124

- Legal Firm: Perkins-Coie, LLP
- Retained as an expert by WIT Legal, LLC on behalf of Perfect Corporation (Petitioner).
- Provided a declaration in support of the IPR petition for US 6,624,843.
- Petitioner filed a motion to dismiss its petition on April 5th, 2022.

Apple Inc. v. Corephotonics, LTD

Jan. 2021 – May 2021

- Legal Firm: Russ, August & Kabat,
- Retained as an expert by WIT Legal, LLC on behalf of Corephotonics in two IPR cases.
- Provided two declarations in support of IPR Petitions IPR2020-00487 & IPR2020-00860.
- Provided a deposition on 04/14/2021.

Davis Polk

Aug. 2020 – Nov. 2021

- Legal Firm: Davis Polk
- Retained as an expert by WIT Legal, LLC
- Provided expert and consulting services for video and point cloud type imagery.

Cravath, Swaine & Moore, LLP

Feb. 2020 – Mar. 2020 and Jan. 2021

- Legal Firm: Cravath, Swaine & Moore, LLP
- Retained as an expert by WIT Legal, LLC
- Evaluated computer vision technology for various clients.
- No reports, depositions or expert testimonies were provided.

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

Wells Fargo & Co. v. Lighthouse Consulting Group

Feb. 2020 – Sept. 2020

US Patent and Trademark Office, Patent Trial and Appeal Board, IPR2020-00758 and IPR2020-00759

- Legal Firm: Winston & Strawn LLP
- Retained as an expert by DOAR on behalf of Petitioner Wells Fargo.
- Submitted two declarations in support of IPR Petitions IPR2020-00758 & IPR2020-00759 for US 8,590,940 and US RE44,274.

3Shape A/S v. Align Technology, Inc.

Jan. 2020 – April 2020

US District Court, District of Delaware, Case No. 18-cv-00886 (consolidated with 18-cv-00697)

- Legal Firm: Buchanan, Ingersoll and Rooney, PC
- Retained as an expert by DOAR on behalf of plaintiff for US Patents-in-Suit Nos. 9,962,244 and 9,629,551 with regards to invalidity.
- Case was transferred to Troutman Pepper LLP very shortly after my engagement.

3Shape A/S et al v. Align Technology, Inc.

Oct. 2019 – Oct. 2020

US Patent and Trademark Office, Patent Trial and Appeal Board, IPR2020-00222 and IPR2020-00223

- Legal Firm: Buchanan, Ingersoll and Rooney, PC
- Retained as an expert by DOAR on behalf of Petitioner 3Shape A/S with respect to US 7,156,661
- Provided two declarations in support of IPR petitions (IPR2020-00223 and IPR2020-00222) for US 7,156,661. Both petitions were filed in December 2019.
- Provided a deposition on July 30th, 2020 in support of IPR2020-00223 that was instituted by PTAB and supporting materials for follow on responses.

Uniloc 2017 LLC v. Netflix, Inc. (Petitioner) (18-cv-2055)

July 2019 – July 2020

US Patent and Trademark Office, Patent Trial and Appeal Board, IPR2020-00044

- Legal Firm: Perkins-Coie, LLP

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

- Retained as an expert by DOAR on behalf of Petitioner Netflix, Inc.
- Provided an expert declaration in support of IPR2020-00044 for US 6,584,229.
- Case was settled in July 2020.

Align Technology, Inc. v. 3Shape A/S et al

Feb. 2019 – Feb. 2022

US District Court, District of Delaware, Case No. 17-cv-01646 (LPS) (CJB)

- Legal Firm: Troutman Pepper LLP
- Retained as an expert by WIT Legal, LLC on behalf of Defendant 3Shape for US Patent-in-Suit No. 9,510,757 ('757 Patent).
- Served as expert for invalidity and non-Infringement for US 9,510,757
- Provided expert reports regarding Invalidity and non-infringement of '757
- Provided a deposition on 10 January 2020
- Case was settled in February 2022.

Certain Dental and Orthodontic Scanners and Software

Feb. 2019 – Oct. 2019

US International Trade Commission, Investigation No. 337-TA-1144 (3Shape v. Align)

- Legal Firm: Pepper Hamilton, PC
- Retained as an expert by DOAR on behalf of respondent 3Shape A/S with respect to US Patent-in-Suit No. 9,299,192 ('192 Patent).
- Served as expert on invalidity, non-infringement and domestic industry.
- Provided expert opinions and rebuttal reports in support of the above proceedings.
- Provided a deposition (8/13/2019).
- Provided trial testimony on October 30th, 2019 (Trial was held Oct. 24-30, 2019) with regards to Invalidity, Non-infringement and Domestic Industry.

3Shape A/S et al v. Align Technology, Inc.

Oct. 2018 – Sept. 2019

US Patent and Trademark Office, Patent Trial and Appeal Board, IPR2019-00132 and IPR2019-00134 and IPR2019-00148

- Legal Firm: Buchanan, Ingersoll and Rooney, PC

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

- Retained as an expert by DOAR on behalf of respondent 3Shape A/S with respect to US 7,112,065, US 9,451,873 and US 9,299,192
- Represented 3Shape (Petitioner) in three IPR Petitions v. Align (Patent Owner).
- Provided three declarations in support of the IPR petitions for US 7,112,065, US 9,299,192 and US 9,451,873. All three petitions were filed in November 2018 and all three were instituted.
- Provided three depositions with regards to US 7,112,065 (8/16/2019), US 9,451,873 (09/18/2019) and US 9,299,192 (09/30/2019).

Blackberry Corp. et al v. Maxell, Ltd

Sept. 2018 – Oct. 2018

US Patent and Trademark Office, Patent Trial and Appeal Board, IPR2019-00087 and IPR2019-00095 and IPR2019-00097

- Legal Firm: Oblon, McClelland, Maier and Neustadt, LLP
- Retained as an expert on behalf of petitioner Blackberry Corp.
- Provided three declarations in support of the IPR petitions for US 9,100, 604 (Joinder), US 6,765, 616 and US 7,995,897.
- Case settled in May 2019.

Exocad GmbH et al v. 3Shape A/S

March 2018 – Sept. 2019

US Patent and Trademark Office, Patent Trial and Appeal Board, IPR2018-00788

- Legal Firm: Buchanan, Ingersoll and Rooney, PC
- Retained as an expert by DOAR on behalf of 3Shape A/S in defending an IPR filings of EXOCAD (Petitioner) v. 3Shape (Patent Owner). Case No. IPR 2018-00788
- Provided a declaration in support of the Patent Owner response for US 9,336,336.
- Provided a deposition on April 1st, 2019.

Certain Intraoral Scanners and Related Hardware and Software

February 2018 – Sept. 2018

US International Trade Commission, Investigation No. 337-TA-1090 & No. 337-TA-1091 (Align v. 3Shape)

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

- Legal Firm: Pepper Hamilton, LLP
- Retained as an expert by DOAR on behalf of respondent 3Shape A/S.
- Provided expert opinions regarding claim construction, noninfringement, and the domestic industry analysis.
- Attended a *Markman* hearing and provided a tutorial for the technology in suit.
- Provided a Deposition on July 16, 2018.
- Provided trial testimony as an expert on Sept. 20th, 2018 with regards to Non-infringement and Domestic Industry.

Nikon Corporation et al v. ASML Netherlands BV et al

July 2017 – Nov. 2017

US Patent and Trademark Office, Patent Trial and Appeal Board, IPR2018-00227

- Legal Firm: Morrison & Foerster
- Retained as an expert on behalf of petitioner Nikon Corporation.
- Provided an expert declaration in support of IPR petition for US 7,209,167.

Raster Printing Innovations, LLC v. Hewlett-Packard Company et al

April 2016 – May 2016

US District Court, Northern District of Illinois, Case No. 15-cv-03967

- Legal Firm: Morgan, Lewis & Bockius, LLP
- Retained as an expert by IMS Expert Services on behalf of defendant Hewlett Packard.
- Contributed to the development of initial invalidity contentions charts.
- Case settled very quickly after my engagement in June 2016.

Qomo Hitevision LLC v. Pathway Innovations and Technologies, Inc.

Nov. 2015 – Jan. 2016

US Patent and Trademark Office, Patent Trial and Appeal Board, IPR2016-00661

- Legal Firm: Mei & Mark, LLP
- Retained as an expert on behalf of petitioner Qomo Hitevision.
- Provided an expert declaration in support of petition for inter partes review.

Sony Corp of America. v. Image Processing Technologies, LLC

Aug. 2014 – Nov. 2014

US Patent and Trademark Office, Patent Trial and Appeal Board

Declaration of Eli Saber in Support of
Petition for *Inter Partes* Review of U.S. Patent No. 9,191,648

- Legal Firm: Lerner, David, Littenberg, Krumholz & Mentlik LLP
- Retained as an expert on behalf of Sony.
- Provided an expert declaration in support of petition to institute inter partes review of US Patent No. 6,959,293.

Image Processing Technologies, LLC v. Canon Inc. et al

June 2011 – Dec. 2012

Case: US District Court, Eastern District of New York, Case No. 10-cv-03867

- Legal Firm: Fitzpatrick, Cella, Harper & Scinto
- Retained as an expert on behalf of defendant Canon Inc.
- Traveled to Japan twice to meet with Canon Technical & Engineering Teams
- Provided reports related to Invalidity, Non-Infringement, Rebuttals, and summary judgement.
- Provided a Deposition in April 2012.