microwave radar sensors), electromagnetic induction (inductive-loop detectors), and vibration (triboelectric, seismic, and inertia-switch sensors). MEMS accelerometers, gyros, and magnetometers are examples of motions sensors.

Workflow: a sequence of tasks implemented in software.

Brief description of the drawings

The above and/or additional objects, features and advantages of the present invention, will be further elucidated by the following illustrative and non-limiting detailed description of embodiments of the present invention, with reference to the appended drawings, wherein:

Fig. 1 shows an example of the system comprising a handheld device and a display.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device.

Fig. 3 shows an example of the handheld device.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

Detailed description

In the following description, reference is made to the accompanying figures, which show by way of illustration how the invention may be practiced.

Fig. 1 shows an example of the system comprising a handheld device and a display. The handheld device 100 is in this example an intraoral dental scanner, which records the 3D geometry of the patient's teeth. The operator 102 moves the scanner along the teeth of the patient 104 for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner comprises motion sensors (not visible) for taken the movement of the scanner into account while creating the 3D model 105 of the scanned teeth. The display 101 is in this example a PC screen displaying the data recorded by the scanner.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device. The motion sensors (not shown) in the handheld device 100, e.g. scanner, provide that the user 102 can determine the view shown on the display 101, e.g. screen, by moving the handheld device 100.

Fig. 2a) shows that pointing the device 100 down can provide that the 3D model 105 of the scanned teeth is shown from a downward viewing angle.

Fig. 2b) shows that holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontally from the front, such that the 3D model 105 of the scanned teeth is shown from the front.

Fig. 3 shows an example of the handheld device.

The handheld device 100 is in this example an intraoral scanner with a pistol-grip. The scanner comprises a housing 106 comprising the pistol-grip part 107, and a tip 108 adapted for insertion in the mouth of the patient. In this example the scanner also is equipped with a button 103 which is an additional element providing user-interface functionality.

The example system as shown in fig. 1, fig. 2 and fig. 3 comprises a device 100 which is a handheld intraoral scanner and a display 101 which is a

computer screen. The operator 102 may be a dentist, an assistant and/or the like. In an example, the action performance or operation functionality of the device 100 is to record some intraoral 3D geometry, and the user interface functionality is to rotate, pan, and zoom the 3D model 105 of the scanned data on the computer screen 101. The integration of the user interface functionality in the device 100 is provided by motion sensors (not visible), which can be accelerometers inside the scanner 100, whose readings determine the orientation, as seen in Figs 2a and 2b, of the display on the screen of the 3D model 105 of the teeth acquired by the scanner 100. Additional functionality, e.g. to start/stop scanning, may be provided by the button 103 as seen in fig. 3. In the example system, the button 103 is located where the user's index finger can reach it conveniently.

In fig. 1 the dentist 102 uses two hands to hold the intraoral scanner 100 while scanning, but it is understood that the scanner 100 can also be held with one hand while scanning. The device 100 can also be held with one or two hands, while changing the perspective of the 3D model 105 in the display 101. The example shown in Figure 1 thus illustrates the advantage of the touchless user interface functionality, because in many clinical situations, the operator 102 should maintain both hands clean, disinfected, or even sterile.

The 3D user interface functionality may be exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, see fig. 1, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth, see figs 2 and 3.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

In step 101 at least one action in a physical 3D environment is performed by means of the handheld device. This action may the scanning of teeth as shown in fig. 1.

In step 102 the physical 3D environment is visually represented by the at least one display. This may be the display of the 3D model of the scanned teeth as seen in fig 1.

In step 103 the view of the represented 3D environment shown on the display is remotely controlled on the display by means of the handheld device. This may be the control of the viewing angle of the 3D model as seen in fig. 2.

All the steps of the method may be repeated one or more times. The order in which the steps are performed may be different than the order described above, which is indicated by the dotted lines in the figure. If one or more of the steps are performed more times, the order of the steps may also be different.

Although some embodiments have been described and shown in detail, the invention is not restricted to them, but may also be embodied in other ways within the scope of the subject matter defined in the following claims. In particular, it is to be understood that other embodiments may be utilised and structural and functional modifications may be made without departing from the scope of the present invention.

In device claims enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims or described in different embodiments does not indicate that a combination of these measures cannot be used to advantage.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers,

steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

The features of the method described above and in the following may be implemented in software and carried out on a data processing system or other processing means caused by the execution of computer-executable instructions. The instructions may be program code means loaded in a memory, such as a RAM, from a storage medium or from another computer via a computer network. Alternatively, the described features may be implemented by hardwired circuitry instead of software or in combination with software.

Literature:

C. Graetzel, T. Fong, S. Grange, and C. Baur. A Non-Contact Mouse for Surgeon-Computer Interaction. Technology and Health Care, 12(3), 2004.

Vogt S., Khamene A., Niemann H., Sauer F., An AR system with intuitive user interface for manipulation and visualization of 3D medical data, Stud. Health Technol. Inform. 2004;98, pp. 397-403.

Embodiments

The following embodiments relates to one aspect of the system as disclosed by the description herein.

1. A system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D environment is represented on the display.

2. The system according to any one or more of the preceding embodiments, wherein the view is defined as viewing angle and/or viewing position.

3. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.

4. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted for changing the rendering of the 3D environment on the display.

5. The system according to any one or more of the preceding embodiments, wherein the at least one action comprises one or more of:

- measuring,
- recording,
- scanning,
- manipulating, and/or
- modifying.

6. The system according to any one or more of the preceding embodiments, wherein the 3D environment comprises one or more 3D objects.

7. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to be held in one hand by an operator.

8. The system according to any one or more of the preceding embodiments, wherein the display is adapted to represent the 3D environment from multiple views..

9. The system according to any one or more of the preceding embodiments, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

10. The system according to any one or more of the preceding embodiments, wherein the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

11. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

12. The system according to any one or more of the preceding embodiments, wherein the 3D geometry of the 3D environment is known a-priori.

13. The system according to any one or more of the preceding embodiments, wherein the handheld device comprises at least one user-interface element.

14. The system according to any one or more of the preceding embodiments, wherein the at least one user-interface element is at least one motion sensor.

15. The system according to any one or more of the preceding embodiments, wherein the handheld device comprises at least two motion sensors providing sensor fusion.

16. The system according to any one or more of the preceding embodiments, wherein the user interface functionality comprises the use of gestures.

17. The system according to any one or more of the preceding embodiments, wherein the gestures are detected by the at least one motion sensor.

18. The system according to any one or more of the preceding embodiments, wherein the handheld device comprises at least one user-interface element other than the at least one motion sensor.

19. The system according to any one or more of the preceding embodiments, wherein the at least one other user-interface element is a touch-sensitive element.

20. The system according to any one or more of the preceding embodiments, wherein the at least one other user-interface element is a button.

21. The system according to any one or more of the preceding embodiments, wherein the at least one other user-interface element is a scroll wheel.

22. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

23. The system according to any of the preceding embodiments, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

24. The system according to any one or more of the preceding embodiments, wherein the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

25. The system according to any one or more of the preceding embodiments, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

26. The system according to any one or more of the preceding embodiments, wherein the view of the 3D environment comprises rendering of texture and/or shading.

27. The system according to any one or more of the preceding embodiments, wherein the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

28. The system according to any one or more of the preceding embodiments, wherein the 3D geometry comprises a 3D surface of the environment.

29. The system according to any one or more of the preceding embodiments, wherein the 3D geometry comprises a 3D volumetric representation of the environment.

30. The system according to any one or more of the preceding embodiments, wherein the handheld device is an intra-oral 3D scanner.

31. The system according to any one or more of the preceding embodiments, wherein the handheld device is a surgical instrument.

32. The system according to any one or more of the preceding embodiments, wherein the handheld device is a mechanical tool.

33. The system according to any one or more of the preceding embodiments, wherein the handheld device is an in-ear 3D scanner.

34. The system according to any one or more of the preceding embodiments, wherein the at least one display is arranged separate from the handheld device.

35. The system according to any one or more of the preceding embodiments, wherein the at least one display is arranged on a cart.

36. The system according to any one or more of the preceding embodiments, wherein the at least one display is defined as a first display, and where the system further comprises a second display.

37. The system according to any one or more of the preceding embodiments, wherein the second display is arranged on the handheld device.

38. The system according to any one or more of the preceding embodiments, wherein the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

39. The system according to any one or more of the preceding embodiments, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

40. The system according to any one or more of the preceding embodiments, wherein the first display and/or the second display provides instructions for the operator.

41. The system according to any one or more of the preceding embodiments, wherein visual information is provided to the operator on one or more means other than the first display.

42. The system according to any one or more of the preceding embodiments, wherein audible information to the operator is provided to the operator.

43. The system according to any one or more of the preceding embodiments, wherein the scanning is performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

44. A method of interaction between a handheld device and at least one display, where the method comprises the steps of:

- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

45. A computer program product comprising program code means for causing a data processing system to perform the method of any one or more of the preceding embodiments, when said program code means are executed on the data processing system.

46. A computer program product according to the previous embodiment, comprising a computer-readable medium having stored there on the program code means.

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DENTAL IMAGING

Claims

1. A system comprising a handheld device and at least one display, where the handheld device is adapted for switching between
- performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and
- remotely controlling the view with which the 3D environment is represented on the display.

2. A system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

3. A system according to any one or more of the preceding claims, wherein means for manually switching between performing the at least one action and remotely controlling the view is provided on the handheld device.

4. A system according to claim 3, wherein the means for manually switching is an actuator, such as a button, a switch or a contact.

5. The system according to any one or more of the preceding claims, wherein the view is defined as viewing angle and/or viewing position.

6. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.

7. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for changing the rendering of the 3D environment on the display.

8. The system according to any one or more of the preceding claims, wherein the at least one action comprises one or more of:

- measuring,
- recording,
- scanning,
- manipulating, and/or
- modifying.

9. The system according to any one or more of the preceding claims, wherein the 3D environment comprises one or more 3D objects.

10. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to be held in one hand by an operator.

11. The system according to any one or more of the preceding claims, wherein the display is adapted to represent the 3D environment from multiple views.

12. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one motion sensor.

13. The system according to any one or more of the preceding claims, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor.

14. The system according to any one or more of the preceding claims, wherein the magnification represented in the at least one display is at least partly determined by the at least one motion sensor.

15. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

16. The system according to any one or more of the preceding claims, wherein the 3D geometry of the 3D environment is known a-priori.

17. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element.

18. The system according to any one or more of the preceding claims, wherein the at least one user-interface element is at least one motion sensor.

19. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least two motion sensors providing sensor fusion.

20. The system according to any one or more of the preceding claims, wherein the user interface functionality comprises the use of gestures.

21. The system according to any one or more of the preceding claims, wherein the gestures are detected by the at least one motion sensor.

22. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element other than the at least one motion sensor.

23. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a touch-sensitive element.

24. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a button.

25. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a scroll wheel.

26. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

27. The system according to any of the preceding claims, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

28. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

29. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

30. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises rendering of texture and/or shading.

31. The system according to any one or more of the preceding claims, wherein the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

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DENTAL IMAGING

32. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D surface of the environment.

33. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D volumetric representation of the environment.

34. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner.

35. The system according to any one or more of the preceding claims, wherein the handheld device is a surgical instrument.

36. The system according to any one or more of the preceding claims, wherein the handheld device is a mechanical tool.

37. The system according to any one or more of the preceding claims, wherein the handheld device is an in-ear 3D scanner.

38. The system according to any one or more of the preceding claims, wherein the at least one display is arranged separate from the handheld device.

39. The system according to any one or more of the preceding claims, wherein the at least one display is arranged on a cart.

40. The system according to any one or more of the preceding claims, wherein the at least one display is defined as a first display, and where the system further comprises a second display.

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DENTAL IMAGING

41. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device.

42. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

43. The system according to any one or more of the preceding claims, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

44. The system according to any one or more of the preceding claims, wherein the first display and/or the second display provides instructions for the operator.

45. The system according to any one or more of the preceding claims, wherein visual information is provided to the operator on one or more means other than the first display.

46. The system according to any one or more of the preceding claims, wherein audible information to the operator is provided to the operator.

47. The system according to any one or more of the preceding claims, wherein the scanning is performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

48. The system according to any one or more of the preceding claims, wherein a graphical pointer is provided on the display for representing the movement of the handheld device when the handheld device is used to

remotely controlling the view with which the 3D environment is represented on the display.

49. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner and the at least one action performed in the physical 3D environment is scanning and that the view is remotely controlled by at least one motion sensor arranged in the handheld device, and wherein an actuator provided on the handheld device switches between performing the at least one action and remotely controlling the view.

50. A method of interaction between a handheld device and at least one display, where the method comprises the steps of:

- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

51. A computer program product comprising program code means for causing a data processing system to perform the method of claim 44, when said program code means are executed on the data processing system.

52. A computer program product according to the previous claim, comprising a computer-readable medium having stored there on the program code means.

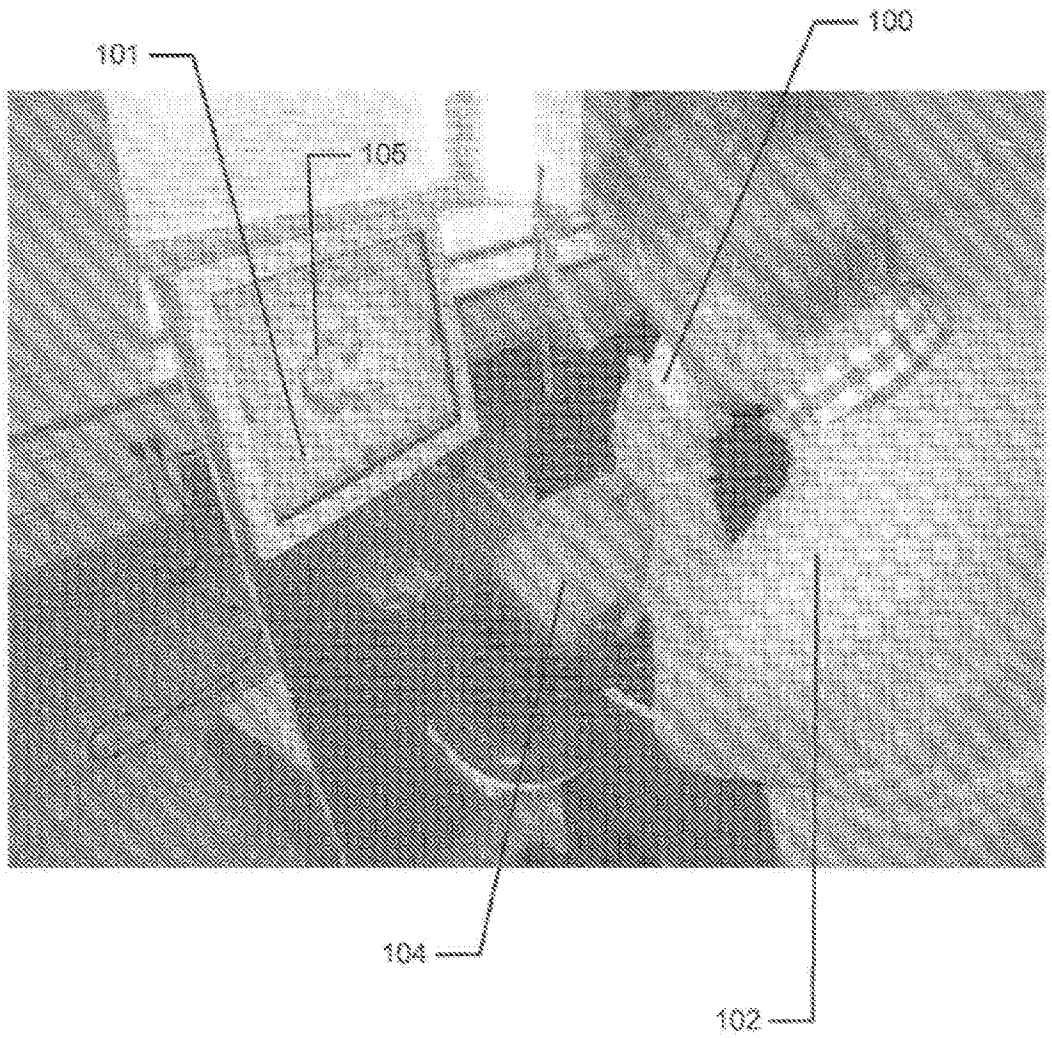


Fig. 1

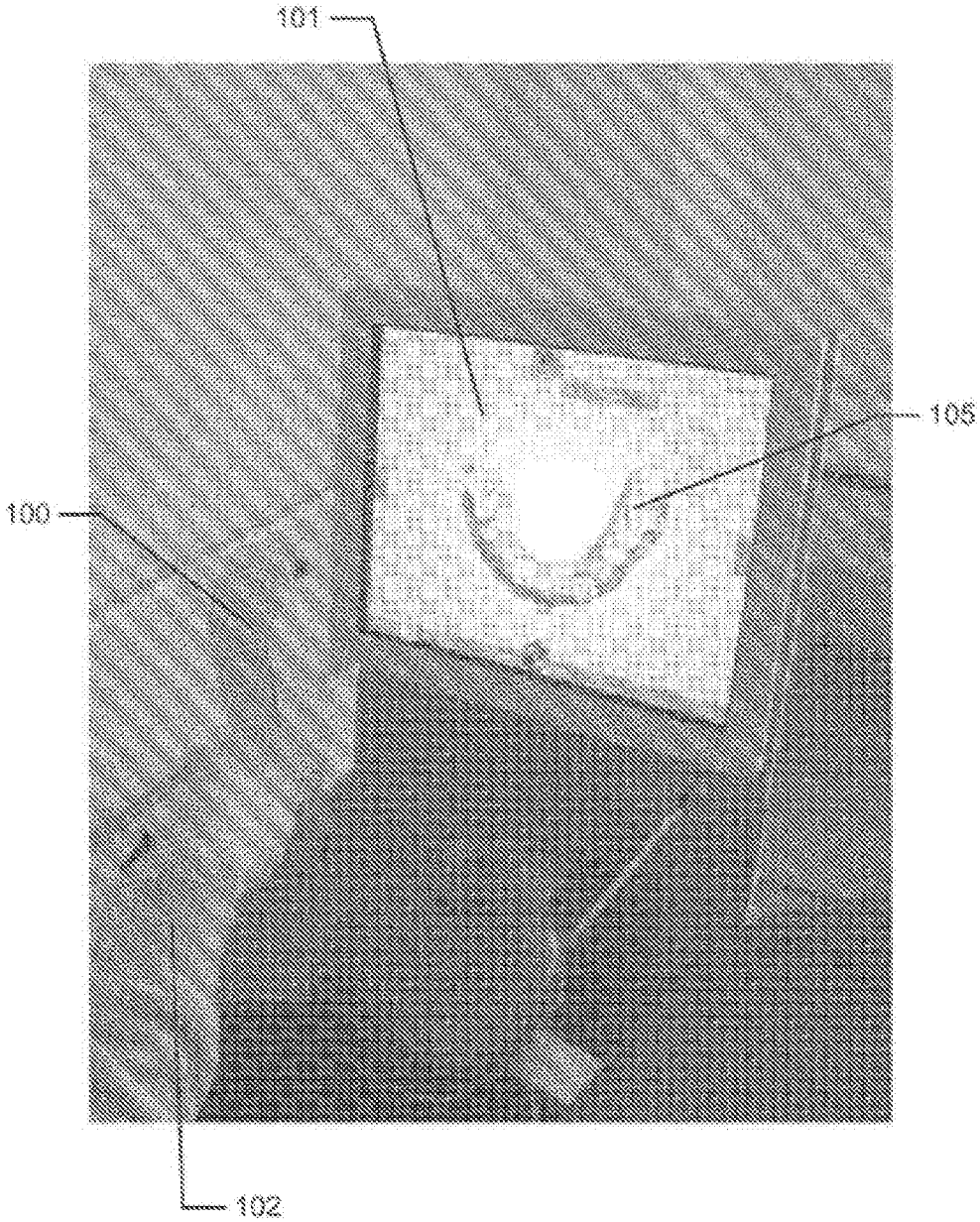


Fig. 2a)

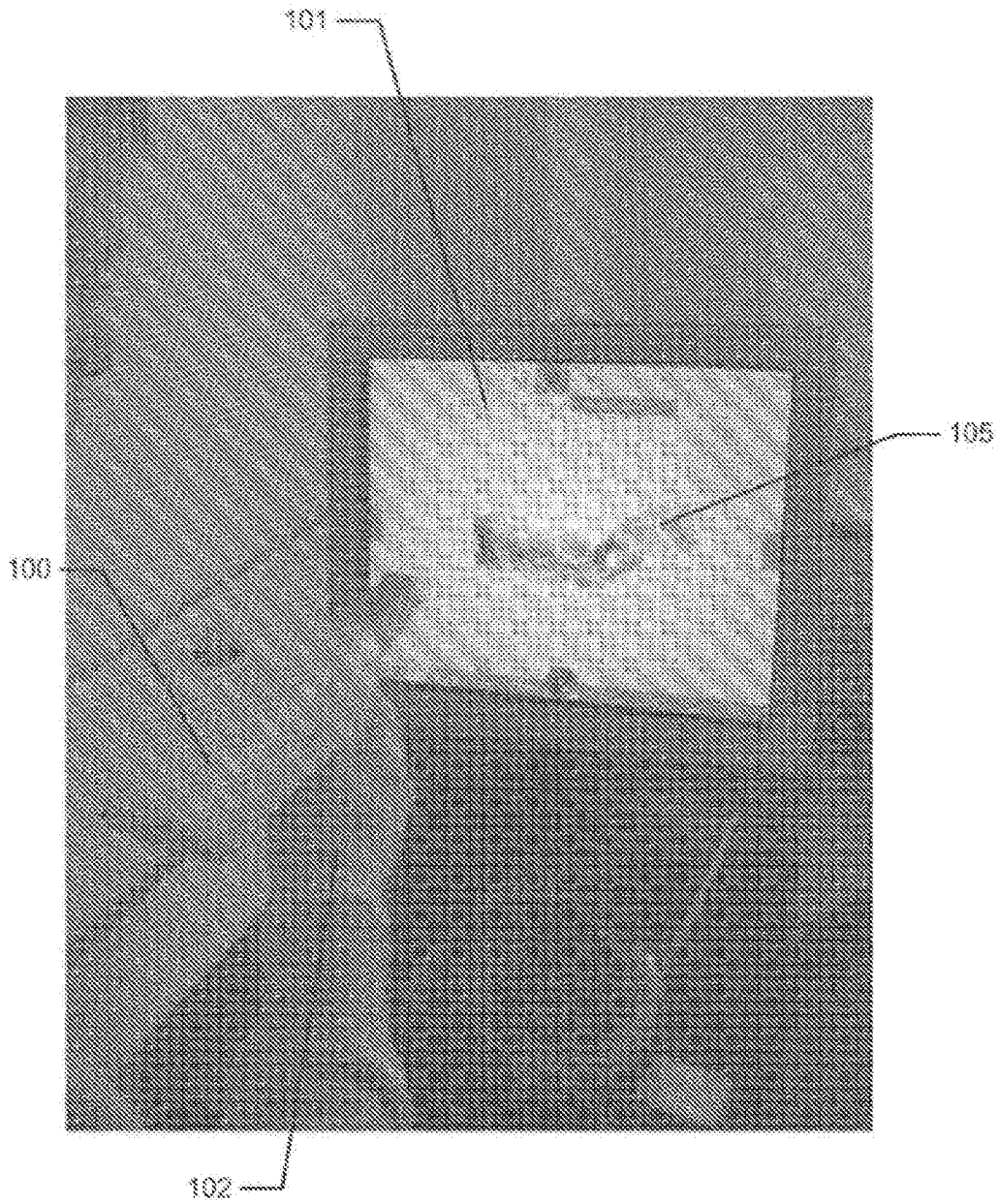


Fig. 2b)

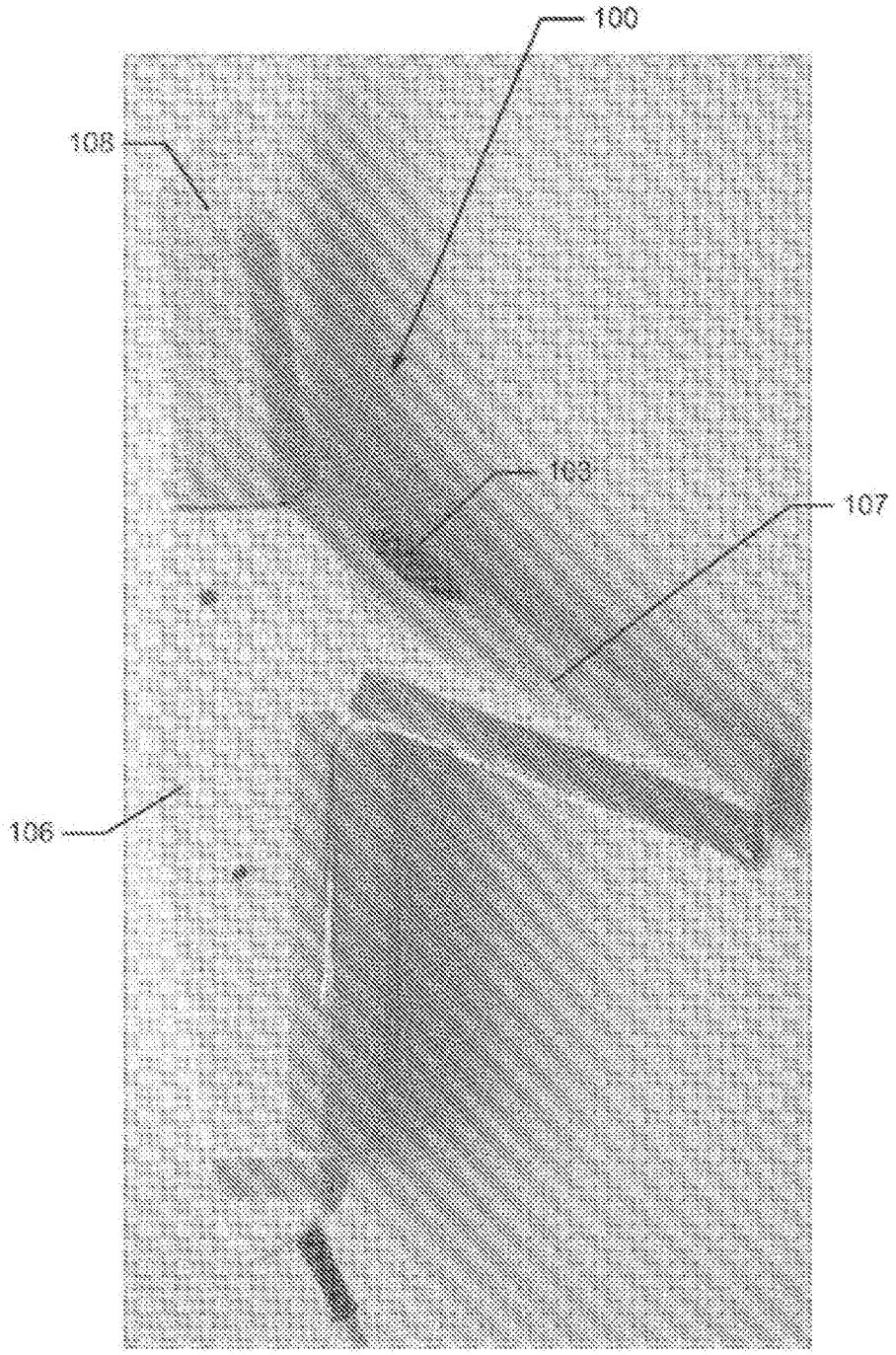


Fig. 3

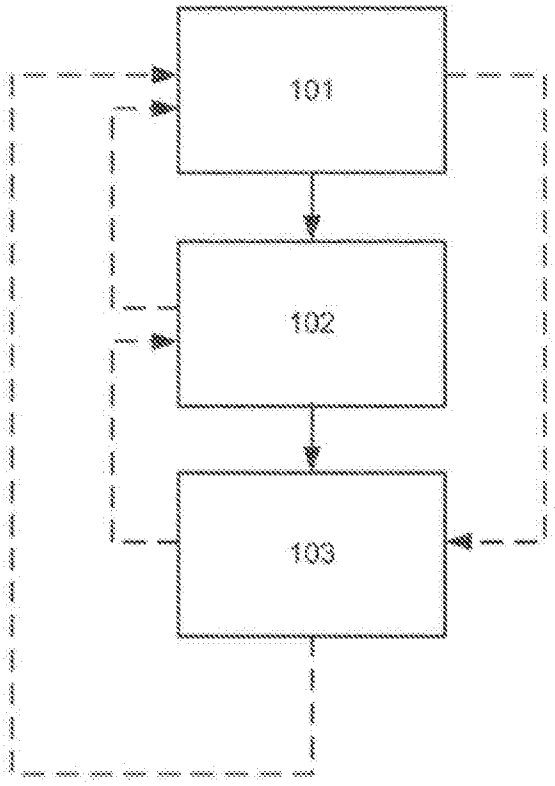


Fig. 4

Exhibit 1004 page 1024 of 1621
DENTAL IMAGING

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK2011/050461

A. CLASSIFICATION OF SUBJECT MATTER
G01B 11/24 (2006.01), A61C 13/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC/EC: G06F, G01B, A61C; ICO: K63F; FT:4C061/CC

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
DK, SE, FI, NO (IPC classes as above)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC, WPI, TXTE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X; A	US 2009/0217207 A1 (KAGERMEIER et al) 2009.08.27, entire application, in particular sections [0007], [0009], [0012]-[0013], [0019] -[0020], [0023], [0035]-[0039], fig. 1-4	1-33, 38-48, 50-52; 34, 49
X; A	WO 2004/066615 A1 (NOKIA CORPORATION) 2004.08.05, page 3, line 16 to page 4, line 2, page 25, line 12, to page 28, line 5.	1, 3-14, 16-33, 38-48, 50-52; 2, 15, 34, 49
X; A	US 2003/0158482 A1 (POLAND et al) 2003.08.21, sections [0032], [0034], figs 6, 8.	1-11, 15-17, 26-33, 38-39, 46, 48, 50-52; 12-14, 18-25, 34, 40, 41-45, 47
A	US 2009/0061381 A1 (DURBIN et al) 2009.03.05, sections [0018]-[0019], [0024]	1-33, 38-52

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17/02/2012	22/02/2012
Name and mailing address of the ISA/ Nordic Patent Institute, Helgeshoj Allé 81, DK-2630 Taastrup, Denmark. Facsimile No. +45 43 50 80 08	Authorized officer Lennart Bitsch Telephone No. +45 43 50 8244

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK2011/050461

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-34, 38-52

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/DK2011/050461

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US2009217207 A1	20090827	CN101513350 A DE102008010717 A1	20090826 20090827
WO2004066615 A1	20040805	US2006146009 A1 EP1588552 A1 AU2003303787 A1	20060706 20051026 20040813
US2003158482 A1	20030821	JP2005517515 A WO03071306 A1 EP1488253 A1 EP1488253 B1 DE60308496T T2 CN1636151 A CN100340867C C AU2003247479 A1 AT340365T T US7141020 B2	20050616 20030828 20041222 20060920 20070606 20050706 20071003 20030909 20061015 20061128
US2009061381 A1	20090305	WO2009033108 A1 KR20100066538 A JP2010538302 A EP2185891 A1 CA2698626 A1	20090312 20100617 20101209 20100519 20090312

Form PCT/ISA/210 (patent family annex) (July 2009)

Continuation of Box no. III

This International Searching Authority found multible inventions.

US 2009/0217207 A1 (KAGERMEIER et al) 2009.08.27 describes a system comprising a handheld device (10) and at least one display (3, 22), where the handheld device is adapted for switching between
-performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment ([0013], [0037]), and
-remotely controlling the view with which the 3D environment is represented on the display ([0007], [0036], [0039])

The general concept described in the independent claim 1 is known from US 2009/0217207, and the application does therefore describe 4 inventions

A: Claims 2-34, 38-52 describe modifications of a system, a method, and a computer program product comprising a handheld device for performing at least one action, and for remotely controlling the view, and wherein the handheld device is an intra-oral 3D scanner
B: Claim 35 describes a system wherein the handheld device of claim 1 is a surgical instrument
C: Claim 36 describes a system wherein the handheld device of claim 1 is a mechanical tool
D: Claim 37 describes a system wherein the handheld device of claim 1 is an in-ear 3D scanner

There is no Single General Inventive Concept among the inventions A, B, C and D, and there is, therefore, not a technical relationship to link the invention as defined in Rules 13.1 and 13.2 PCT.

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System with 3D user interface integration

Abstract

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D environment is represented on the display.

(fig. 2a) should be published)

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Claims:

1. A system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D environment is represented on the display.

2. The system according to any one or more of the preceding claims, wherein the view is defined as viewing angle and/or viewing position.

3. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.

4. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for changing the rendering of the 3D environment on the display.

5. The system according to any one or more of the preceding claims, wherein the at least one action comprises one or more of:
- measuring,
- recording,
- scanning,
- manipulating, and/or
- modifying.

6. The system according to any one or more of the preceding claims, wherein the 3D environment comprises one or more 3D objects.

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7. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to be held in one hand by an operator.

8. The system according to any one or more of the preceding claims, wherein the display is adapted to represent the 3D environment from multiple views..

9. The system according to any one or more of the preceding claims, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

10. The system according to any one or more of the preceding claims, wherein the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

11. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

12. The system according to any one or more of the preceding claims, wherein the 3D geometry of the 3D environment is known a-priori.

13. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element.

14. The system according to any one or more of the preceding claims, wherein the at least one user-interface element is at least one motion sensor.

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15. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least two motion sensors providing sensor fusion.

16. The system according to any one or more of the preceding claims, wherein the user interface functionality comprises the use of gestures.

17. The system according to any one or more of the preceding claims, wherein the gestures are detected by the at least one motion sensor.

18. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user-interface element other than the at least one motion sensor.

19. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a touch-sensitive element.

20. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a button.

21. The system according to any one or more of the preceding claims, wherein the at least one other user-interface element is a scroll wheel.

22. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

23. The system according to any of the preceding claims, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

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24. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

25. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

26. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises rendering of texture and/or shading.

27. The system according to any one or more of the preceding claims, wherein the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

28. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D surface of the environment.

29. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D volumetric representation of the environment.

30. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner.

31. The system according to any one or more of the preceding claims, wherein the handheld device is a surgical instrument.

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32. The system according to any one or more of the preceding claims, wherein the handheld device is a mechanical tool.

33. The system according to any one or more of the preceding claims, wherein the handheld device is an in-ear 3D scanner.

34. The system according to any one or more of the preceding claims, wherein the at least one display is arranged separate from the handheld device.

35. The system according to any one or more of the preceding claims, wherein the at least one display is arranged on a cart.

36. The system according to any one or more of the preceding claims, wherein the at least one display is defined as a first display, and where the system further comprises a second display.

37. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device.

38. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

39. The system according to any one or more of the preceding claims, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

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40. The system according to any one or more of the preceding claims, wherein the first display and/or the second display provides instructions for the operator.

41. The system according to any one or more of the preceding claims, wherein visual information is provided to the operator on one or more means other than the first display.

42. The system according to any one or more of the preceding claims, wherein audible information to the operator is provided to the operator.

43. The system according to any one or more of the preceding claims, wherein the scanning is performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

44. A method of interaction between a handheld device and at least one display, where the method comprises the steps of:
- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

45. A computer program product comprising program code means for causing a data processing system to perform the method of any one or more of the preceding claims, when said program code means are executed on the data processing system.

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46. A computer program product according to the previous claim, comprising a computer-readable medium having stored there on the program code means.

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System with 3D user interface integration

Field of the invention

This invention generally relates to a method and a system comprising a handheld device and at least one display.

Background of the invention

3D visualization is important in many fields of industry and medicine, where 3D information is becoming more and more predominant.

Displaying and inspecting 3D information is inherently difficult. To fully understand a 3D object or entire environment on a screen, the user should generally be able to rotate the object or scene, such that many or preferentially all surfaces are displayed. This is true even if for 3D displays, e.g. stereoscopic or holographic, where from a given viewing position and with a given viewing angle, the user will only see some surfaces of an arbitrary 3D environment. Often, the user will also want to zoom into details or zoom out for an overview.

Various user interaction devices are in use for software that displays 3D data; these devices are: 3D mice, space balls, and touch screens. The operation of these current interaction devices requires physically touching them.

Physically touching a user-interaction device can be a disadvantage in medical applications due to risks of cross-contamination between patients or between patient and operator, or in industrial applications in dirty environments.

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Several non-touch user interfaces for 3D data viewing in medical applications have been described in the literature. Vogt et al (2004) describe a touchless interactive system for in-situ visualization of 3D medical imaging data. The user interface is based on tracking of reflective markers, where a camera is mounted on the physician's head. Graetzel et al (2004) describe a touchless system that interprets hand gestures as mouse actions. It is based on stereo vision and intended for use in minimally invasive surgery.

It remains a problem to improve systems that require user interfaces for view control, which for example can be used for clinical purposes.

Summary

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which said 3D environment is represented on the display

The system disclosed here performs the integration of 3D user interface functionality with any other handheld device with other operating functionality, such that the operator ideally only touches this latter device that is intended to be touched. A particular example of such a handheld device is one that records some 3D geometry, for example a handheld 3D scanner.

The handheld device is a multi-purpose device, such as a dual-purpose or two-purpose device, i.e. a device both for performing actions in the physical 3D environment, such as measuring and manipulating, and for remotely controlling the view of the 3D environment on the display.

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Geometrically, a view is determined by the virtual observer's/camera's position and orientation relative to the 3D environment or its visual representation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor.

The virtual observer's and the 3D environment's position and orientation are always relative to each other. In terms of user experience in software systems with 3D input devices, the user may feel that for example, he/she is moving the 3D environment while remaining stationary himself/herself, but there is always an equivalent movement of the virtual observer/camera that gives the same results on the display. Often, descriptions of 3D software systems use the expression "pan" to indicate an apparent translational movement of the 3D environment, "rotate" to indicate a rotational movement of the 3D environment, and "zoom" to indicate a change in magnification factor.

Graphically, a view can represent a 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

All of the touch-less prior art systems are 3D user interface devices only. In many prior art applications, the operator using such user interface device will also hold and work with another device that really is the central device in the overall application, e.g. a medical instrument.

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It is thus an advantage of the present system that the 3D user-interface functionality is integrated in the central device, which is used for performing some kind of action.

In some embodiments the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.

In some embodiments the handheld device is adapted for changing the rendering of the 3D environment on the display.

In some embodiments the view is defined as viewing angle and/or viewing position.

In some embodiments the at least one action comprises one or more of the actions of:
- measuring,
- recording,
- scanning,
- manipulating,
- modifying.

In some embodiments the 3D environment comprises one or more 3D objects.

In some embodiments the handheld device is adapted to be held in one hand by an operator.

In some embodiments the display is adapted to represent the 3D environment from multiple views.

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In some embodiments the display is adapted to represent the 3D environment from different viewing angles and/or viewing positions.

In some embodiments the view of the 3D environment in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

In some embodiments the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

In some embodiments the handheld device is adapted to record the 3D geometry of the 3D environment.

Thus the handheld device may be an intraoral dental scanner, which records the 3D geometry of a patient's teeth. The operator may move the scanner along the teeth of the patient for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner may comprise motion sensors for taken the movement of the scanner into account while creating the 3D model of the scanned teeth.

The 3D model of the teeth may be shown on a display, and the display may for example be a PC screen and/or the like.

The user interface functionality may comprise incorporating motion sensors in the scanner to provide that the user can determine the view on the screen by moving the scanner. Pointing the scanner down can provide that the scanned teeth are shown given a downward viewing angle. Holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontal.

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In some embodiments the handheld device comprises at least one user-interface element.

The system may be equipped with a button as an additional element providing the user-interface functionality.

In an example the handheld device is a handheld intraoral scanner, and the display is a computer screen. The operator or user may be a dentist, an assistant and/or the like. The operation functionality of the device may be to record some intraoral 3D geometry, and the user interface functionality may be to rotate, pan, and zoom the scanned data on the computer screen.

In some embodiments the at least one user-interface element is at least one motion sensor.

Thus the integration of the user interface functionality in the device may be provided by motion sensors, which can be accelerometers inside the scanner, whose readings determine the orientation of the display on the screen of the 3D model of the teeth acquired by the scanner. Additional functionality, e.g. to start/stop scanning, may be provided by a button. The button may be located where the operator's or user's index finger can reach it conveniently.

Prior art intraoral scanners use a touch screen, a trackball, or a mouse to determine the view in the display. These prior art user interface devices can be inconvenient, awkward and difficult to use, and they can be labor-intensive, and thus costly to sterilize or disinfect. An intraoral scanner should always be disinfected between scanning different patients, because the scanner is in and may come in contact with the mouth or other parts of the patient being scanned.

The operator or user, e.g. dentist, may use one hand or both hands to hold the intraoral scanner while scanning, and the scanner may be light enough

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and comfortable to be held with just one hand for a longer time while scanning.

The device can also be held with one or two hands, while using the device as remote control for e.g. changing the view in the display. It is an advantage of the touchless user interface functionality that in clinical situations, the operator can maintain both hands clean, disinfected, or even sterile.

An advantage of the system is that it allows an iterative process of working in a 3D environment without releasing the handheld device during said process. For the above intraoral scanning system example, the operator, e.g. dentist, can record some teeth surface geometry with a handheld device that is an intraoral scanner, inspect coverage of the surface recording by using that same handheld device to move, e.g. rotate, the recorded surface on the display, e.g. a computer screen, detect possible gaps or holes in the coverage of the scanned teeth, and then for example arrange the scanner in the region where the gaps were located and continue recording teeth surface geometry there. Over this entire iterative cycle, which can be repeated more than once, such as as many times as required for obtaining a desired scan coverage of the teeth, the dentist does not have to lay the handheld intraoral scanner out of his or her hands.

In some embodiments, the 3D user interface functionality is exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth. The key characteristic and advantage of the system, again, is that the dentist can exploit the dual and integrated functionality, that is operation and user interface, of the scanner without laying it out of his or her hands.

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The above intraoral scanning system is an example of an embodiment. Other examples for operation functionality or performing actions could be drilling, welding, grinding, cutting, soldering, photographing, filming, measuring, executing some surgical procedure etc..

The display of the system can be a 2D computer screen, a 3D display that projects stereoscopic image pairs, a volumetric display creating a 3D effect, such as a swept-volume display, a static volume display, a parallax barrier display, a holographic display etc.. Even with a 3D display, the operator has only one viewing position and viewing angle relative to the 3D environment at a time. The operator can move his/her head to assume another viewing position and/or viewing angle physically, but generally, it may be more convenient to use the handheld device with its built-in user interface functionality, e.g. the remote controlling, to change the viewing position and/or viewing angle represented in the display.

In some embodiments the system comprises multiple displays, or one or more displays that are divided into regions. For example, several sub-windows on a PC screen can represent different views of the 3D environment. The handheld device can be used to change the view in all of them, or only some of them.

In some embodiments the user interface functionality comprises the use of gestures.
Gestures made by e.g. the operator can be used to change, shift or toggle between sub-windows, and the user-interface functionality can be limited to an active sub-window or one of several displays.

In some embodiments the gestures are adapted to be detected by the at least one motion sensor. Gestures can alternatively and/or additionally be detected by range sensors or other sensors that record body motion.

The operator does not have to constantly watch the at least one display of the system. In many applications, the operator will shift between viewing and possible manipulating the display and performing another operation with the handheld device. Thus it is an advantage that the operator does not have to touch other user interface devices. However, in some cases it may not be possible for the operator to fully avoid touching other devices, and in these cases it is an advantage that fewer touches are required compared to a system where a handheld device does not provide any user interface functionality at all.

In some embodiments the at least one display is arranged separate from the handheld device.

In some embodiments the at least one display is defined as a first display, and where the system further comprises a second display.

In some embodiments the second display is arranged on the handheld device.

In some embodiments the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

In some embodiments the second display indicates where the handheld device is positioned relative to the 3D environment.

In some embodiments the first display and/or the second display provides instructions for the operator.

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The display(s) can be arranged in multiple ways. For example, they can be mounted on a wall, placed on some sort of stand or a cart, placed on a rack or desk, or other.

In some embodiments at least one display is mounted on the device itself. It can be advantageous to have a display on the device itself because with such an arrangement, the operator's eyes need not focus alternatingly between different distances. In some cases, the operating functionality may require a close look at the device and the vicinity of the 3D environment it operates in, and this may be at a distance at most as far away as the operator's hand. Especially in crowded environments such as dentist's clinics, surgical operation theatres, or industrial workplaces, it may be difficult to place an external display closely to the device.

In some embodiments visual information is provided to the operator on one or more means other than the first display.

In some embodiments audible information to the operator is provided to the operator.

Thus in some embodiments, the system provides additional information to the operator. In some embodiments, the system includes other visual clues shown on means other than the display(s), such as LEDs on the device. In some embodiments, the system provides audible information to the operator, for example by different sounds and/or by speech.

Said information provided to the operator can comprise instructions for use, warnings, and the like.

The information can aid with improving the action performance or operation functionality of the device, for example by indicating how well an action or operation is being performed, and/or instructions to the operator aimed at

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improving the ease of the action or operation and/or the quality of the action or operation's results. For example, a LED can change in color and/or flashing frequency. In a scanner, the information can relate to how well the scanned 3D environment is in focus and/or to scan quality and/or to scan coverage. The information can comprise instructions on how best to position the scanner such as to attain good scan quality and/or scan coverage. The instructions can be used for planning and/or performing bracket placement. The instructions can be in the form of a messenger system to the operator.

In some embodiments, some 3D user interface functionality is provided by at least one motion sensor built into the device. Examples of motion sensors are accelerometers, gyros, and magnetometers and/or the like. These sensors can sense rotations, lateral motion, and/or combinations thereof. Other motion sensors use infrared sensing. For example, at least one infrared sensor can be mounted on the device and at least one infrared emitter can be mounted in the surroundings of the device. Conversely, the at least one emitter can be mounted on the device, and the at least one sensors in the surroundings. Yet another possibility is to use infrared reflector(s) on the device and both sensor(s) and emitter(s) on the surroundings, or again conversely. Thus motion can be sensed by a variety of principles.

Through proper signal processing, some sensors can recognize additional operator actions; for example gestures such as taps, waving, or shaking of the handheld device. Thus, these gestures can also be exploited in the 3D user interface functionality.

In some embodiments the handheld device comprises at least two motion sensors providing sensor fusion. Sensor fusion can be used to achieve a better motion signal from for example raw gyro, accelerometer, and/or magnetometer data. Sensor fusion can be implemented in ICs such as the InvenSense MPU 3000.

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In some embodiments the handheld device comprises at least one user-interface element other than the at least one motion sensor.

In some embodiments the at least one other user-interface element is a touch-sensitive element.

In some embodiments the at least one other user-interface element is a button.

In some embodiments the at least one other user-interface element is a scroll-wheel.

In some embodiments, user interface functionality is provided through additional elements on the device. Thus these additional elements can for example be buttons, scroll wheels, touch-sensitive fields, proximity sensors and/or the like

The additional user interface elements can be exploited or utilized in a workflow suitable for the field of application of the device. The workflow may be implemented in some user software application that may also control the display and thus the view represented thereon. A given interface element can supply multiple user inputs to the software. For example, a button can provide both a single click and a double click. For example, a double click can mean to advance to a subsequent step in a workflow. For the example of intraoral scanning, three steps within the workflow can be to scan the lower mouth, the upper mouth, and the bite. A touch-sensitive field can provide strokes in multiple directions each with a different effect, etc. Providing multiple user inputs from a user interface elements is advantageous because the number of user interface elements on the device can be reduced relative

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to a situation where each user interface element only provides one user input.

The motion sensors can also be exploited in a workflow. For example, lifting the device, which can be sensed by an accelerometer, can represent some type of user input, for example to start some action. In a device that is a scanner, it may start scanning. Conversely, placing the device back in some sort of holder, which can be sensed by an accelerometer as no acceleration occur over some period of time, can stop said action.

If the action performed by the device is some kind of recording, for example scanning, for example 3D scanning, the results of the recording can also be exploited as user inputs, possibly along with user inputs from other user interface elements. For example, with a 3D scanner with a limited depth of field, it may be possible to detect whether any objects within the 3D environments are present in the volume corresponding to this depth of field by detecting whether any 3D points are recorded. User inputs can depend on such detected presence. For example, a button click on an intraoral scanner can provide a different user input depending on whether the scanner is in the mouth, where teeth are detectable, or significantly away from and outside the mouth. Also the effect of motion sensor signals can be interpreted differently for either situation. For example, the scanner may only change the view represented on the display when it is outside the mouth.

In some embodiments the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

In some embodiments the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

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In some embodiments the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

In some embodiments the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

In some embodiments the view of the 3D environment comprises rendering of texture and/or shading.

In some embodiments the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

Thus in some embodiments the user interface functionality comprises changing the view with which the 3D environment is displayed. Changes in view can comprise changes in viewing angle, viewing position, magnification and/or the like. A change in viewing angle can naturally be effected by rotating the device. Rotation is naturally sensed by the aid of gyros and/or relative to gravity sensed by an accelerometer. Zooming, i.e. a change in magnification, can for example be achieved by pushing the handheld device forward and backward, respectively. A translational change of the viewing position, i.e., panning, can for example be achieved by pushing the handheld device up/down and/or sideways.

In some embodiments the user interface functionality comprises selecting or choosing items on a display or any other functionality provided by graphical user interfaces in computers known in the art. The operator may perform the selection. The Lava C.O.S scanner marketed by 3M ESPE has additional buttons on the handheld device, but it is not possible to manipulate the view

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by these. Their only purpose is to allow navigation through a menu system, and to start/stop scanning.

In some embodiments the user interface functionality comprises manipulating the 3D environment displayed on the screen. For example, the operator may effect deformations or change the position or orientation of objects in the 3D environment. Thus, in some embodiments the user interface functionality comprises virtual user interface functionality, which can be that the 3D data are manipulated, but the physical 3D environment in which the device operates may not be manipulated.

In some embodiments the handheld device is an intraoral scanner and/or an in-the-ear scanner. If the scanner comprises a tip, this tip may be exchanged whereby the scanner can become suitable for scanning in the mouth or in the ear. Since the ear is a smaller cavity than the mouth, the tip for fitting into an ear may be smaller than a tip for fitting in the mouth.

In some embodiments the handheld device is a surgical instrument. In some embodiments, the surgical instrument comprises at least one motion sensor, which is built-in in the instrument.

In some embodiments the handheld device is a mechanical tool. In some embodiments, the tool has at least one motion sensor built in. In other embodiments, other user-interface elements are built in as well, for example buttons, scroll wheels, touch-sensitive fields, or proximity sensors.

In some embodiment the 3D geometry of the 3D environment is known a-priori or a 3D representation of the environment is known a priori, i.e. before the actions (s) are performed. For example in surgery, a CT scan may have been taken before the surgical procedure. The handheld device in this example could be a surgical instrument that a physician needs to apply in the

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proper 3D position. To make sure this proper position is reached, it could be beneficial to view the 3D environment from multiple perspectives interactively, i.e. without having to release the surgical instrument.

An advantage of the system, also in the above surgery example, is the ability of the handheld device to record the 3D environment at least partially, typically in a 3D field-of-view that is smaller than the volume represented in the a-priori data. The 3D data recorded by the handheld device can be registered in real time with the a-priori data, such that the position and orientation of the device can be detected.

In some embodiments the 3D geometry comprises a 3D surface of the environment.

In some embodiments the 3D geometry comprises a 3D volumetric representation of the environment.

Thus the 3D environment can be displayed as volumetric data, or as surface, or a combination thereof. Volumetric data are typically represented by voxels. Voxels can comprise multiple scalar values. Surface data are typically represented as meshed, such as triangulated meshes, or point clouds.

The scanning may be performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

The present invention relates to different aspects including the system described above and in the following, and corresponding systems, methods, devices, uses, and/or product means, each yielding one or more of the benefits and advantages described in connection with the first mentioned aspect, and each having one or more embodiments corresponding to the

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embodiments described in connection with the first mentioned aspect and/or disclosed in the appended claims.

In particular, disclosed herein is a method of interaction between a handheld device and at least one display, where the method comprises the steps of:
- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

Furthermore, the invention relates to a computer program product comprising program code means for causing a data processing system to perform the method according to any of the embodiments, when said program code means are executed on the data processing system, and a computer program product, comprising a computer-readable medium having stored there on the program code means.

According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment from multiple perspectives,
where said device is adapted to be held in one hand by an operator, and where the perspective represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment in multiple views,

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where said device is adapted to be held in one hand by an operator, where the view represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device, and where the device has at least one touch-sensitive user interface element.

Definitions

3D geometry: A constellation of matter or its virtual representation in a three-dimensional space.

3D environment: A constellation of physical objects each having a 3D geometry in a three-dimensional space.

View: The way a 3D environment is represented on a display. Geometrically, a view is determined by the virtual observer's/camera's position and orientation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor. Graphically, a view can show the 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

Functionality: A purpose or intended use.

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Performing action(s) or operating functionality: Actions or functionality that includes some type of interaction with a 3D environment, such as measuring, modifying, manipulating, recording, touching, sensing, scanning, moving, transforming, cutting, welding, chemically treating, cleaning, etc. The term "operating" is thus not directed to surgical procedures, but operating may comprise surgical procedures.

User Interface Functionality: Functionality for interaction between a human user and a machine with a display.

Handheld device: An object that has at least one functionality and that is held by a human operator's hand or both hands while performing this at least one functionality.

3D scanner: A device that analyzes a real-world object or 3D environment to collect data on its shape and possibly its appearance.

Coverage of scan: The degree to which a physical surface is represented by recorded data after a scanning operation.

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

Workflow: a sequence of tasks implemented in software.

Brief description of the drawings

The above and/or additional objects, features and advantages of the present invention, will be further elucidated by the following illustrative and non-limiting detailed description of embodiments of the present invention, with reference to the appended drawings, wherein:

Fig. 1 shows an example of the system comprising a handheld device and a display.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device.

Fig. 3 shows an example of the handheld device.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

Detailed description

In the following description, reference is made to the accompanying figures, which show by way of illustration how the invention may be practiced.

Fig. 1 shows an example of the system comprising a handheld device and a display. The handheld device 100 is in this example an intraoral dental scanner, which records the 3D geometry of the patient's teeth. The operator 102 moves the scanner along the teeth of the patient 104 for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner comprises motion sensors (not visible) for taken the movement of the scanner into

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account while creating the 3D model 105 of the scanned teeth. The display 101 is in this example a PC screen displaying the data recorded by the scanner.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device. The motion sensors (not shown) in the handheld device 100, e.g. scanner, provide that the user 102 can determine the view shown on the display 101, e.g. screen, by moving the handheld device 100.

Fig. 2a) shows that pointing the device 100 down can provide that the 3D model 105 of the scanned teeth is shown from a downward viewing angle.

Fig. 2b) shows that holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontally from the front, such that the 3D model 105 of the scanned teeth is shown from the front.

Fig. 3 shows an example of the handheld device.

The handheld device 100 is in this example an intraoral scanner with a pistol-grip. The scanner comprises a housing 106 comprising the pistol-grip part 107, and a tip 108 adapted for insertion in the mouth of the patient. In this example the scanner also is equipped with a button 103 which is an additional element providing user-interface functionality.

The example system as shown in fig. 1, fig. 2 and fig. 3 comprises a device 100 which is a handheld intraoral scanner and a display 101 which is a computer screen. The operator 102 may be a dentist, an assistant and/or the like. In an example, the action performance or operation functionality of the device 100 is to record some intraoral 3D geometry, and the user interface functionality is to rotate, pan, and zoom the 3D model 105 of the scanned data on the computer screen 101. The integration of the user interface functionality in the device 100 is provided by motion sensors (not visible), which can be accelerometers inside the scanner 100, whose readings

determine the orientation, as seen in Figs 2a and 2b, of the display on the screen of the 3D model 105 of the teeth acquired by the scanner 100. Additional functionality, e.g. to start/stop scanning, may be provided by the button 103 as seen in fig. 3. In the example system, the button 103 is located where the user's index finger can reach it conveniently.

In fig. 1 the dentist 102 uses two hands to hold the intraoral scanner 100 while scanning, but it is understood that the scanner 100 can also be held with one hand while scanning. The device 100 can also be held with one or two hands, while changing the perspective of the 3D model 105 in the display 101. The example shown in Figure 1 thus illustrates the advantage of the touchless user interface functionality, because in many clinical situations, the operator 102 should maintain both hands clean, disinfected, or even sterile.

The 3D user interface functionality may be exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, see fig. 1, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth, see figs 2 and 3.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

In step 101 at least one action in a physical 3D environment is performed by means of the handheld device. This action may the scanning of teeth as shown in fig. 1.

In step 102 the physical 3D environment is visually represented by the at least one display. This may be the display of the 3D model of the scanned teeth as seen in fig 1.

In step 103 the view of the represented 3D environment shown on the display is remotely controlled on the display by means of the handheld device. This may be the control of the viewing angle of the 3D model as seen in fig. 2.

All the steps of the method may be repeated one or more times. The order in which the steps are performed may be different than the order described above, which is indicated by the dotted lines in the figure. If one or more of the steps are performed more times, the order of the steps may also be different.

Although some embodiments have been described and shown in detail, the invention is not restricted to them, but may also be embodied in other ways within the scope of the subject matter defined in the following claims. In particular, it is to be understood that other embodiments may be utilised and structural and functional modifications may be made without departing from the scope of the present invention.

In device claims enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims or described in different embodiments does not indicate that a combination of these measures cannot be used to advantage.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

The features of the method described above and in the following may be implemented in software and carried out on a data processing system or other processing means caused by the execution of computer-executable instructions. The instructions may be program code means loaded in a memory, such as a RAM, from a storage medium or from another computer via a computer network. Alternatively, the described features may be

implemented by hardwired circuitry instead of software or in combination with software.

Literature:

C. Graetzel, T. Fong, S. Grange, and C. Baur. A Non-Contact Mouse for Surgeon-Computer Interaction. Technology and Health Care, 12(3), 2004.

Vogt S., Khamene A., Niemann H., Sauer F., An AR system with intuitive user interface for manipulation and visualization of 3D medical data, Stud. Health Technol. Inform. 2004;98, pp. 397-403.

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Doc Code: **TR.PROV**
Document Description: Provisional Cover Sheet (SB16)

PTO/SB/16 (04-07)
Approved for use through 06/30/2010 OMB 0651-0032
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Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

Inventor(s)

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Given Name	Middle Name	Family Name	City	State	Country
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All Inventors Must Be Listed -- Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. — Add

Title of Invention	System with 3D user interface integration
Attorney Docket Number (if applicable)	3SHAPEP018P

Correspondence Address

Direct all correspondence to (select one):

(•) The address corresponding to Customer Number	( ) Firm or Individual Name
Customer Number	64874

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

(•) No.

( ) Yes, the name of the U.S. Government agency and the Government contract number are:

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Document Description: Provisional Cover Sheet (SB16)

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Entity Status

Applicant claims small entity status under 37 CFR 1.27

(•) Yes, applicant qualifies for small entity status under 37 CFR 1.27

( ) No

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Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Fredrik Mollborn/			Date (YYYY-MM-DD)	2010-12-08
First Name	Fredrik	Last Name	Mollborn	Registration Number (If appropriate)	48587

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

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6. A record in this system of records may be disclosed, as a routine use, t o a n other federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
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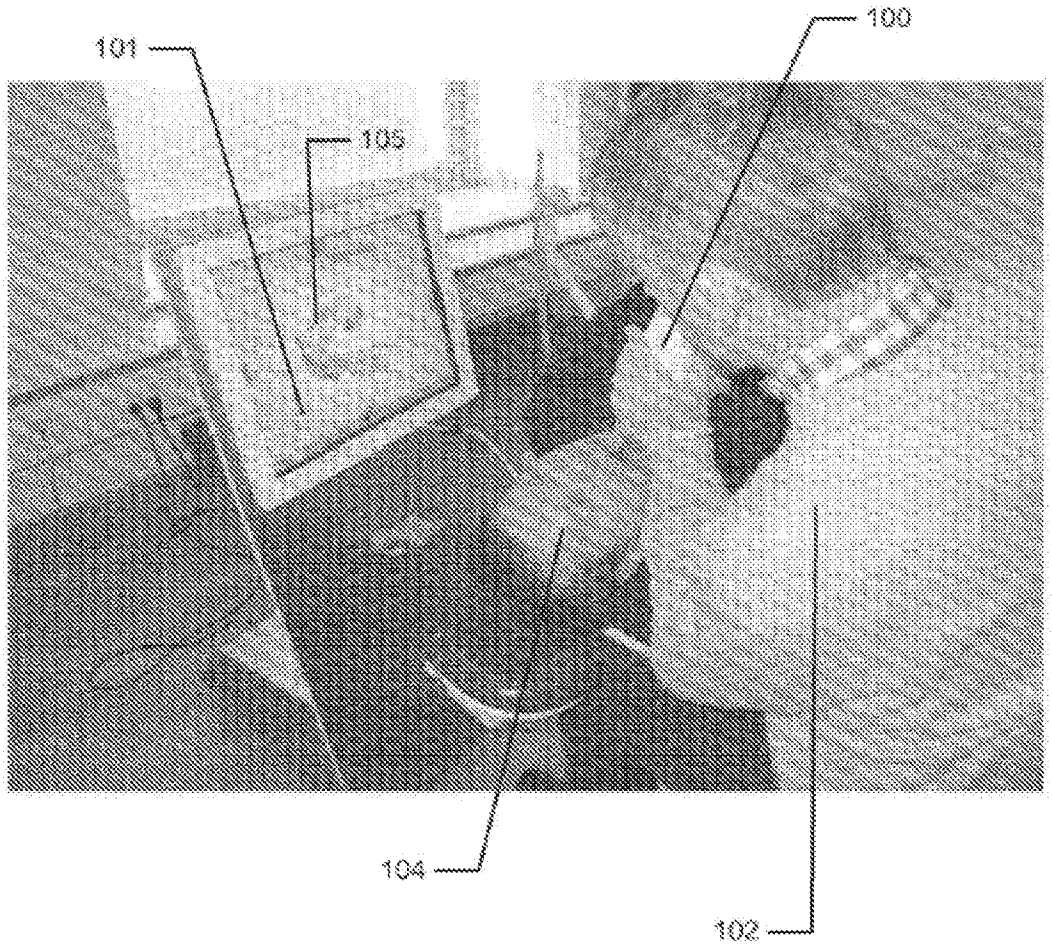


Fig. 1

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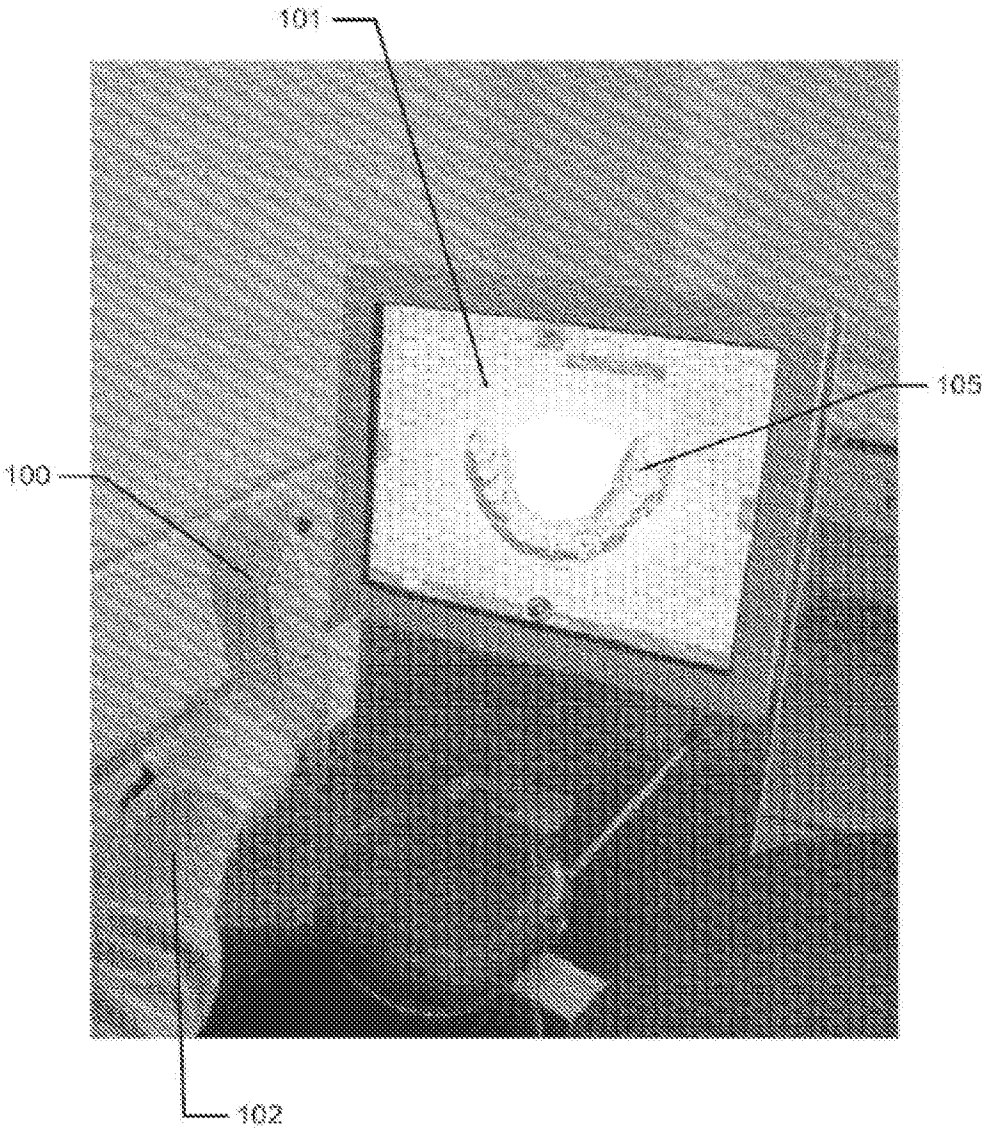


Fig. 2a)

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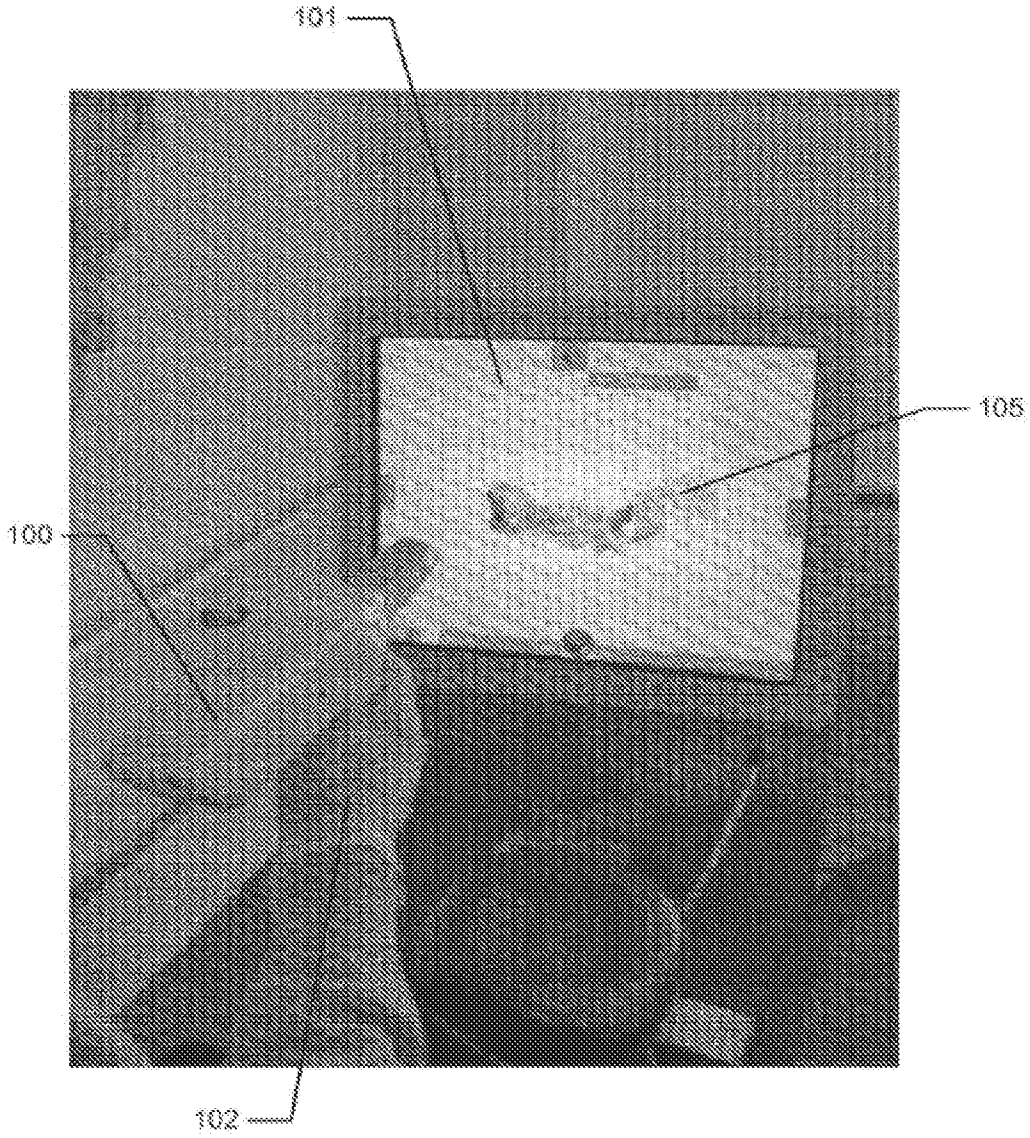


Fig. 2b)

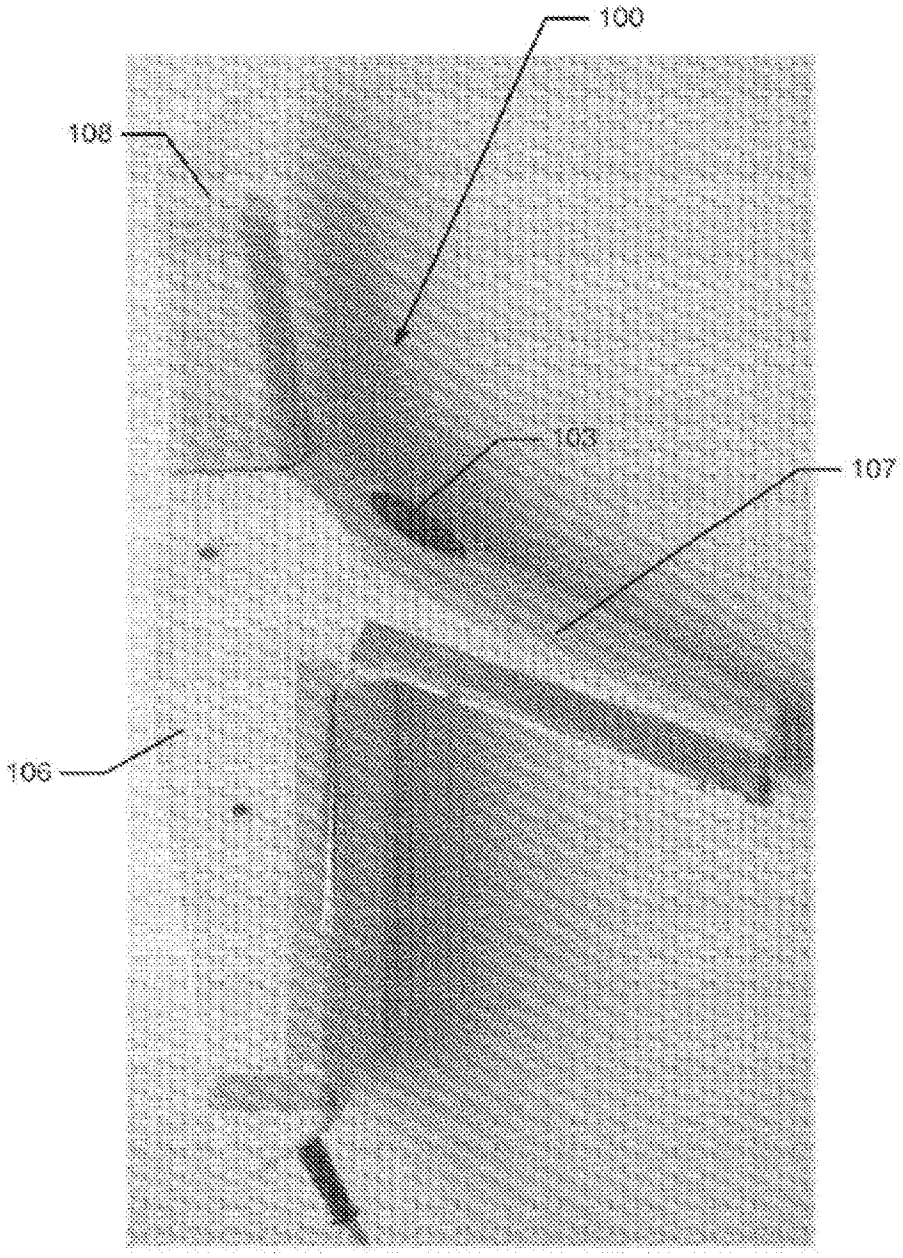


Fig. 3

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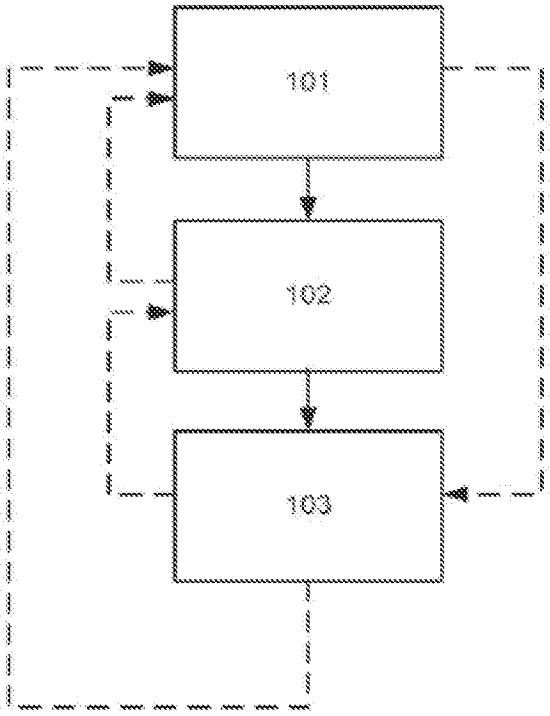


Fig. 4

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Electronic Acknowledgement Receipt	
EFS ID:	8923128
Application Number:	61420138
International Application Number:	
Confirmation Number:	8620
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First Named Inventor/Applicant Name:	Karl J. Hollenbeck
Customer Number:	64974
Filer:	Fredrik Mollborn
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Exhibit 1004 page 1071 of 1621
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1		Provisional_Spec_Claims_Abstract.pdf	118803 sha1	yes	32
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	24	
	Claims		25	31	
	Abstract		32	32	
Warnings:					
Information:					
2	Drawings-other than black and white line drawings	Provisional_Drawings.pdf	6403852 sha1	no	9
Warnings:					
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3	Provisional Cover Sheet (SB16)	ProvisionalSB.pdf	1000153 sha1	no	3
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Denmark

Title: System with 3D user interface integration

IPC: (1): G 01 B 11/24 (2006.01), A 61 C 13/00 (2006.01), G 06 F 1/00 (2006.01)

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20 December 2011

Danish Patent and Trademark Office
Ministry of Economic and Business Affairs
General Director Jesper Kongstad

System with 3D user interface integration

Field of the invention

This invention generally relates to a method and a system comprising a handheld device and at least one display.

Background of the invention

3D visualization is important in many fields of industry and medicine, where 3D information is becoming more and more predominant.

Displaying and inspecting 3D information is inherently difficult. To fully understand a 3D object or entire environment on a screen, the user should generally be able to rotate the object or scene, such that many or preferentially all surfaces are displayed. This is true even if for 3D displays, e.g. stereoscopic or holographic, where from a given viewing position and with a given viewing angle, the user will only see some surfaces of an arbitrary 3D environment. Often, the user will also want to zoom into details or zoom out for an overview.

Various user interaction devices are in use for software that displays 3D data; these devices are: 3D mice, space balls, and touch screens. The operation of these current interaction devices requires physically touching them.

Physically touching a user-interaction device can be a disadvantage in medical applications due to risks of cross-contamination between patients or between patient and operator, or in industrial applications in dirty environments.

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Several non-touch user interfaces for 3D data viewing in medical applications have been described in the literature. Vogt et al (2004) describe a touchless interactive system for in-situ visualization of 3D medical imaging data. The user interface is based on tracking of reflective markers, where a camera is mounted on the physician's head. Graetzel et al (2004) describe a touchless system that interprets hand gestures as mouse actions. It is based on stereo vision and intended for use in minimally invasive surgery.

It remains a problem to improve systems that require user interfaces for view control, which for example can be used for clinical purposes.

Summary

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which said 3D environment is represented on the display

The system disclosed here performs the integration of 3D user interface functionality with any other handheld device with other operating functionality, such that the operator ideally only touches this latter device that is intended to be touched. A particular example of such a handheld device is one that records some 3D geometry, for example a handheld 3D scanner.

The handheld device is a multi-purpose device, such as a dual-purpose or two-purpose device, i.e. a device both for performing actions in the physical 3D environment, such as measuring and manipulating, and for remotely controlling the view of the 3D environment on the display.

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Geometrically, a view is determined by the virtual observer's/camera's position and orientation relative to the 3D environment or its visual representation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor.

The virtual observer's and the 3D environment's position and orientation are always relative to each other. In terms of user experience in software systems with 3D input devices, the user may feel that for example, he/she is moving the 3D environment while remaining stationary himself/herself, but there is always an equivalent movement of the virtual observer/camera that gives the same results on the display. Often, descriptions of 3D software systems use the expression "pan" to indicate an apparent translational movement of the 3D environment, "rotate" to indicate a rotational movement of the 3D environment, and "zoom" to indicate a change in magnification factor.

Graphically, a view can represent a 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

All of the touch-less prior art systems are 3D user interface devices only. In many prior art applications, the operator using such user interface device will also hold and work with another device that really is the central device in the overall application, e.g. a medical instrument.

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It is thus an advantage of the present system that the 3D user-interface functionality is integrated in the central device, which is used for performing some kind of action.

In some embodiments the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.

In some embodiments the handheld device is adapted for changing the rendering of the 3D environment on the display.

In some embodiments the view is defined as viewing angle and/or viewing position.

In some embodiments the at least one action comprises one or more of the actions of:
- measuring,
- recording,
- scanning,
- manipulating,
- modifying.

In some embodiments the 3D environment comprises one or more 3D objects.

In some embodiments the handheld device is adapted to be held in one hand by an operator.

In some embodiments the display is adapted to represent the 3D environment from multiple views.

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In some embodiments the display is adapted to represent the 3D environment from different viewing angles and/or viewing positions.

In some embodiments the view of the 3D environment in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

In some embodiments the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

In some embodiments the handheld device is adapted to record the 3D geometry of the 3D environment.

Thus the handheld device may be an intraoral dental scanner, which records the 3D geometry of a patient's teeth. The operator may move the scanner along the teeth of the patient for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner may comprise motion sensors for taken the movement of the scanner into account while creating the 3D model of the scanned teeth.

The 3D model of the teeth may be shown on a display, and the display may for example be a PC screen and/or the like.

The user interface functionality may comprise incorporating motion sensors in the scanner to provide that the user can determine the view on the screen by moving the scanner. Pointing the scanner down can provide that the scanned teeth are shown given a downward viewing angle. Holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontal.

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In some embodiments the handheld device comprises at least one user-interface element.

The system may be equipped with a button as an additional element providing the user-interface functionality.

In an example the handheld device is a handheld intraoral scanner, and the display is a computer screen. The operator or user may be a dentist, an assistant and/or the like. The operation functionality of the device may be to record some intraoral 3D geometry, and the user interface functionality may be to rotate, pan, and zoom the scanned data on the computer screen.

In some embodiments the at least one user-interface element is at least one motion sensor.

Thus the integration of the user interface functionality in the device may be provided by motion sensors, which can be accelerometers inside the scanner, whose readings determine the orientation of the display on the screen of the 3D model of the teeth acquired by the scanner. Additional functionality, e.g. to start/stop scanning, may be provided by a button. The button may be located where the operator's or user's index finger can reach it conveniently.

Prior art intraoral scanners use a touch screen, a trackball, or a mouse to determine the view in the display. These prior art user interface devices can be inconvenient, awkward and difficult to use, and they can be labor-intensive, and thus costly to sterilize or disinfect. An intraoral scanner should always be disinfected between scanning different patients, because the scanner is in and may come in contact with the mouth or other parts of the patient being scanned.

The operator or user, e.g. dentist, may use one hand or both hands to hold the intraoral scanner while scanning, and the scanner may be light enough

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and comfortable to be held with just one hand for a longer time while scanning.

The device can also be held with one or two hands, while using the device as remote control for e.g. changing the view in the display. It is an advantage of the touchless user interface functionality that in clinical situations, the operator can maintain both hands clean, disinfected, or even sterile.

An advantage of the system is that it allows an iterative process of working in a 3D environment without releasing the handheld device during said process. For the above intraoral scanning system example, the operator, e.g. dentist, can record some teeth surface geometry with a handheld device that is an intraoral scanner, inspect coverage of the surface recording by using that same handheld device to move, e.g. rotate, the recorded surface on the display, e.g. a computer screen, detect possible gaps or holes in the coverage of the scanned teeth, and then for example arrange the scanner in the region where the gaps were located and continue recording teeth surface geometry there. Over this entire iterative cycle, which can be repeated more than once, such as as many times as required for obtaining a desired scan coverage of the teeth, the dentist does not have to lay the handheld intraoral scanner out of his or her hands.

In some embodiments, the 3D user interface functionality is exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth. The key characteristic and advantage of the system, again, is that the dentist can exploit the dual and integrated functionality, that is operation and user interface, of the scanner without laying it out of his or her hands.

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The above intraoral scanning system is an example of an embodiment. Other examples for operation functionality or performing actions could be drilling, welding, grinding, cutting, soldering, photographing, filming, measuring, executing some surgical procedure etc..

The display of the system can be a 2D computer screen, a 3D display that projects stereoscopic image pairs, a volumetric display creating a 3D effect, such as a swept-volume display, a static volume display, a parallax barrier display, a holographic display etc.. Even with a 3D display, the operator has only one viewing position and viewing angle relative to the 3D environment at a time. The operator can move his/her head to assume another viewing position and/or viewing angle physically, but generally, it may be more convenient to use the handheld device with its built-in user interface functionality, e.g. the remote controlling, to change the viewing position and/or viewing angle represented in the display.

In some embodiments the system comprises multiple displays, or one or more displays that are divided into regions. For example, several sub-windows on a PC screen can represent different views of the 3D environment. The handheld device can be used to change the view in all of them, or only some of them.

In some embodiments the user interface functionality comprises the use of gestures.
Gestures made by e.g. the operator can be used to change, shift or toggle between sub-windows, and the user-interface functionality can be limited to an active sub-window or one of several displays.

In some embodiments the gestures are adapted to be detected by the at least one motion sensor. Gestures can alternatively and/or additionally be detected by range sensors or other sensors that record body motion.

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The operator does not have to constantly watch the at least one display of the system. In many applications, the operator will shift between viewing and possible manipulating the display and performing another operation with the handheld device. Thus it is an advantage that the operator does not have to touch other user interface devices. However, in some cases it may not be possible for the operator to fully avoid touching other devices, and in these cases it is an advantage that fewer touches are required compared to a system where a handheld device does not provide any user interface functionality at all.

In some embodiments the at least one display is arranged separate from the handheld device.

In some embodiments the at least one display is defined as a first display, and where the system further comprises a second display.

In some embodiments the second display is arranged on the handheld device.

In some embodiments the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.

In some embodiments the second display indicates where the handheld device is positioned relative to the 3D environment.

In some embodiments the first display and/or the second display provides instructions for the operator.

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The display(s) can be arranged in multiple ways. For example, they can be mounted on a wall, placed on some sort of stand or a cart, placed on a rack or desk, or other.

In some embodiments at least one display is mounted on the device itself. It can be advantageous to have a display on the device itself because with such an arrangement, the operator's eyes need not focus alternatingly between different distances. In some cases, the operating functionality may require a close look at the device and the vicinity of the 3D environment it operates in, and this may be at a distance at most as far away as the operator's hand. Especially in crowded environments such as dentist's clinics, surgical operation theatres, or industrial workplaces, it may be difficult to place an external display closely to the device.

In some embodiments visual information is provided to the operator on one or more means other than the first display.

In some embodiments audible information to the operator is provided to the operator.

Thus in some embodiments, the system provides additional information to the operator. In some embodiments, the system includes other visual clues shown on means other than the display(s), such as LEDs on the device. In some embodiments, the system provides audible information to the operator, for example by different sounds and/or by speech.

Said information provided to the operator can comprise instructions for use, warnings, and the like.

The information can aid with improving the action performance or operation functionality of the device, for example by indicating how well an action or operation is being performed, and/or instructions to the operator aimed at

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improving the ease of the action or operation and/or the quality of the action or operation's results. For example, a LED can change in color and/or flashing frequency. In a scanner, the information can relate to how well the scanned 3D environment is in focus and/or to scan quality and/or to scan coverage. The information can comprise instructions on how best to position the scanner such as to attain good scan quality and/or scan coverage. The instructions can be used for planning and/or performing bracket placement. The instructions can be in the form of a messenger system to the operator.

In some embodiments, some 3D user interface functionality is provided by at least one motion sensor built into the device. Examples of motion sensors are accelerometers, gyros, and magnetometers and/or the like. These sensors can sense rotations, lateral motion, and/or combinations thereof. Other motion sensors use infrared sensing. For example, at least one infrared sensor can be mounted on the device and at least one infrared emitter can be mounted in the surroundings of the device. Conversely, the at least one emitter can be mounted on the device, and the at least one sensors in the surroundings. Yet another possibility is to use infrared reflector(s) on the device and both sensor(s) and emitter(s) on the surroundings, or again conversely. Thus motion can be sensed by a variety of principles.

Through proper signal processing, some sensors can recognize additional operator actions; for example gestures such as taps, waving, or shaking of the handheld device. Thus, these gestures can also be exploited in the 3D user interface functionality.

In some embodiments the handheld device comprises at least two motion sensors providing sensor fusion. Sensor fusion can be used to achieve a better motion signal from for example raw gyro, accelerometer, and/or magnetometer data. Sensor fusion can be implemented in ICs such as the InvenSense MPU 3000.

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In some embodiments the handheld device comprises at least one user-interface element other than the at least one motion sensor.

In some embodiments the at least one other user-interface element is a touch-sensitive element.

In some embodiments the at least one other user-interface element is a button.

In some embodiments the at least one other user-interface element is a scroll-wheel.

In some embodiments, user interface functionality is provided through additional elements on the device. Thus these additional elements can for example be buttons, scroll wheels, touch-sensitive fields, proximity sensors and/or the like

The additional user interface elements can be exploited or utilized in a workflow suitable for the field of application of the device. The workflow may be implemented in some user software application that may also control the display and thus the view represented thereon. A given interface element can supply multiple user inputs to the software. For example, a button can provide both a single click and a double click. For example, a double click can mean to advance to a subsequent step in a workflow. For the example of intraoral scanning, three steps within the workflow can be to scan the lower mouth, the upper mouth, and the bite. A touch-sensitive field can provide strokes in multiple directions each with a different effect, etc. Providing multiple user inputs from a user interface elements is advantageous because the number of user interface elements on the device can be reduced relative

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to a situation where each user interface element only provides one user input.

The motion sensors can also be exploited in a workflow. For example, lifting the device, which can be sensed by an accelerometer, can represent some type of user input, for example to start some action. In a device that is a scanner, it may start scanning. Conversely, placing the device back in some sort of holder, which can be sensed by an accelerometer as no acceleration occur over some period of time, can stop said action.

If the action performed by the device is some kind of recording, for example scanning, for example 3D scanning, the results of the recording can also be exploited as user inputs, possibly along with user inputs from other user interface elements. For example, with a 3D scanner with a limited depth of field, it may be possible to detect whether any objects within the 3D environments are present in the volume corresponding to this depth of field by detecting whether any 3D points are recorded. User inputs can depend on such detected presence. For example, a button click on an intraoral scanner can provide a different user input depending on whether the scanner is in the mouth, where teeth are detectable, or significantly away from and outside the mouth. Also the effect of motion sensor signals can be interpreted differently for either situation. For example, the scanner may only change the view represented on the display when it is outside the mouth.

In some embodiments the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

In some embodiments the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

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In some embodiments the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

In some embodiments the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

In some embodiments the view of the 3D environment comprises rendering of texture and/or shading.

In some embodiments the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

Thus in some embodiments the user interface functionality comprises changing the view with which the 3D environment is displayed. Changes in view can comprise changes in viewing angle, viewing position, magnification and/or the like. A change in viewing angle can naturally be effected by rotating the device. Rotation is naturally sensed by the aid of gyros and/or relative to gravity sensed by an accelerometer. Zooming, i.e. a change in magnification, can for example be achieved by pushing the handheld device forward and backward, respectively. A translational change of the viewing position, i.e., panning, can for example be achieved by pushing the handheld device up/down and/or sideways.

In some embodiments the user interface functionality comprises selecting or choosing items on a display or any other functionality provided by graphical user interfaces in computers known in the art. The operator may perform the selection. The Lava C.O.S scanner marketed by 3M ESPE has additional buttons on the handheld device, but it is not possible to manipulate the view

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by these. Their only purpose is to allow navigation through a menu system, and to start/stop scanning.

In some embodiments the user interface functionality comprises manipulating the 3D environment displayed on the screen. For example, the operator may effect deformations or change the position or orientation of objects in the 3D environment. Thus, in some embodiments the user interface functionality comprises virtual user interface functionality, which can be that the 3D data are manipulated, but the physical 3D environment in which the device operates may not be manipulated.

In some embodiments the handheld device is an intraoral scanner and/or an in-the-ear scanner. If the scanner comprises a tip, this tip may be exchanged whereby the scanner can become suitable for scanning in the mouth or in the ear. Since the ear is a smaller cavity than the mouth, the tip for fitting into an ear may be smaller than a tip for fitting in the mouth.

In some embodiments the handheld device is a surgical instrument. In some embodiments, the surgical instrument comprises at least one motion sensor, which is built-in in the instrument.

In some embodiments the handheld device is a mechanical tool. In some embodiments, the tool has at least one motion sensor built in. In other embodiments, other user-interface elements are built in as well, for example buttons, scroll wheels, touch-sensitive fields, or proximity sensors.

In some embodiment the 3D geometry of the 3D environment is known a-priori or a 3D representation of the environment is known a priori, i.e. before the actions (s) are performed. For example in surgery, a CT scan may have been taken before the surgical procedure. The handheld device in this example could be a surgical instrument that a physician needs to apply in the

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proper 3D position. To make sure this proper position is reached, it could be beneficial to view the 3D environment from multiple perspectives interactively, i.e. without having to release the surgical instrument.

An advantage of the system, also in the above surgery example, is the ability of the handheld device to record the 3D environment at least partially, typically in a 3D field-of-view that is smaller than the volume represented in the a-priori data. The 3D data recorded by the handheld device can be registered in real time with the a-priori data, such that the position and orientation of the device can be detected.

In some embodiments the 3D geometry comprises a 3D surface of the environment.

In some embodiments the 3D geometry comprises a 3D volumetric representation of the environment.

Thus the 3D environment can be displayed as volumetric data, or as surface, or a combination thereof. Volumetric data are typically represented by voxels. Voxels can comprise multiple scalar values. Surface data are typically represented as meshed, such as triangulated meshes, or point clouds.

The scanning may be performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.

The present invention relates to different aspects including the system described above and in the following, and corresponding systems, methods, devices, uses, and/or product means, each yielding one or more of the benefits and advantages described in connection with the first mentioned aspect, and each having one or more embodiments corresponding to the

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embodiments described in connection with the first mentioned aspect and/or disclosed in the appended claims.

In particular, disclosed herein is a method of interaction between a handheld device and at least one display, where the method comprises the steps of:

- performing at least one action in a physical 3D environment by means of the handheld device;
- visually representing the physical 3D environment by the at least one display; and
- remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

Furthermore, the invention relates to a computer program product comprising program code means for causing a data processing system to perform the method according to any of the embodiments, when said program code means are executed on the data processing system, and a computer program product, comprising a computer-readable medium having stored there on the program code means.

According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment from multiple perspectives,
where said device is adapted to be held in one hand by an operator, and where the perspective represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

According to another aspect, disclosed is a system comprising a handheld device for operating in a 3D environment and at least one display for visualizing said environment, where the display is adapted to represent said environment in multiple views,

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where said device is adapted to be held in one hand by an operator, where the view represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device, and where the device has at least one touch-sensitive user interface element.

Definitions

3D geometry: A constellation of matter or its virtual representation in a three-dimensional space.

3D environment: A constellation of physical objects each having a 3D geometry in a three-dimensional space.

View: The way a 3D environment is represented on a display. Geometrically, a view is determined by the virtual observer's/camera's position and orientation. If the display is two-dimensional, the view is also determined by the type of projection. A view may also be determined by a magnification factor. Graphically, a view can show the 3D environment by means of photographs or as some kind of virtual representation such as a computer graphic, or similar. A computer graphic can be rendered for example with texture and/or shading and/or virtual light sources and/or light models for surface properties. A computer graphic can also be a simplified representation of the 3D environment, for example a mesh, an outline, or an otherwise simplified representation. All or parts of the 3D environment can also be rendered with some degree of transparency. A view may represent the 3D environment in total or only parts thereof.

Functionality: A purpose or intended use.

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Performing action(s) or operating functionality: Actions or functionality that includes some type of interaction with a 3D environment, such as measuring, modifying, manipulating, recording, touching, sensing, scanning, moving, transforming, cutting, welding, chemically treating, cleaning, etc. The term "operating" is thus not directed to surgical procedures, but operating may comprise surgical procedures.

User Interface Functionality: Functionality for interaction between a human user and a machine with a display.

Handheld device: An object that has at least one functionality and that is held by a human operator's hand or both hands while performing this at least one functionality.

3D scanner: A device that analyzes a real-world object or 3D environment to collect data on its shape and possibly its appearance.

Coverage of scan: The degree to which a physical surface is represented by recorded data after a scanning operation.

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

Workflow: a sequence of tasks implemented in software.

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Brief description of the drawings

The above and/or additional objects, features and advantages of the present invention, will be further elucidated by the following illustrative and non-limiting detailed description of embodiments of the present invention, with reference to the appended drawings, wherein:

Fig. 1 shows an example of the system comprising a handheld device and a display.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device.

Fig. 3 shows an example of the handheld device.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

Detailed description

In the following description, reference is made to the accompanying figures, which show by way of illustration how the invention may be practiced.

Fig. 1 shows an example of the system comprising a handheld device and a display. The handheld device 100 is in this example an intraoral dental scanner, which records the 3D geometry of the patient's teeth. The operator 102 moves the scanner along the teeth of the patient 104 for capturing the 3D geometry of the relevant teeth, e.g. all teeth. The scanner comprises motion sensors (not visible) for taken the movement of the scanner into

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account while creating the 3D model 105 of the scanned teeth. The display 101 is in this example a PC screen displaying the data recorded by the scanner.

Fig. 2 shows an example of user interface functionality in the form of remote controlling using the handheld device. The motion sensors (not shown) in the handheld device 100, e.g. scanner, provide that the user 102 can determine the view shown on the display 101, e.g. screen, by moving the handheld device 100.

Fig. 2a) shows that pointing the device 100 down can provide that the 3D model 105 of the scanned teeth is shown from a downward viewing angle.

Fig. 2b) shows that holding the scanner in a horizontal position can provide that the viewing angle is likewise horizontally from the front, such that the 3D model 105 of the scanned teeth is shown from the front.

Fig. 3 shows an example of the handheld device.

The handheld device 100 is in this example an intraoral scanner with a pistol-grip. The scanner comprises a housing 106 comprising the pistol-grip part 107, and a tip 106 adapted for insertion in the mouth of the patient. In this example the scanner also is equipped with a button 103 which is an additional element providing user-interface functionality.

The example system as shown in fig. 1, fig. 2 and fig. 3 comprises a device 100 which is a handheld intraoral scanner and a display 101 which is a computer screen. The operator 102 may be a dentist, an assistant and/or the like. In an example, the action performance or operation functionality of the device 100 is to record some intraoral 3D geometry, and the user interface functionality is to rotate, pan, and zoom the 3D model 105 of the scanned data on the computer screen 101. The integration of the user interface functionality in the device 100 is provided by motion sensors (not visible), which can be accelerometers inside the scanner 100, whose readings

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determine the orientation, as seen in Figs 2a and 2b, of the display on the screen of the 3D model 105 of the teeth acquired by the scanner 100. Additional functionality, e.g. to start/stop scanning, may be provided by the button 103 as seen in fig. 3. In the example system, the button 103 is located where the user's index finger can reach it conveniently.

In fig. 1 the dentist 102 uses two hands to hold the intraoral scanner 100 while scanning, but it is understood that the scanner 100 can also be held with one hand while scanning. The device 100 can also be held with one or two hands, while changing the perspective of the 3D model 105 in the display 101. The example shown in Figure 1 thus illustrates the advantage of the touchless user interface functionality, because in many clinical situations, the operator 102 should maintain both hands clean, disinfected, or even sterile.

The 3D user interface functionality may be exploited in a separate location than the operation functionality. For the above intraoral scanning system example, the scanning operation is performed in the oral cavity of the patient, see fig. 1, while the user interface functionality is more flexibly exploited when the scanner is outside the patient's mouth, see figs 2 and 3.

Fig. 4 shows an example of a flow-chart of a method of interaction between a handheld device and a display.

In step 101 at least one action in a physical 3D environment is performed by means of the handheld device. This action may the scanning of teeth as shown in fig. 1.

In step 102 the physical 3D environment is visually represented by the at least one display. This may be the display of the 3D model of the scanned teeth as seen in fig 1.

In step 103 the view of the represented 3D environment shown on the display is remotely controlled on the display by means of the handheld device. This may be the control of the viewing angle of the 3D model as seen in fig. 2.

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All the steps of the method may be repeated one or more times. The order in which the steps are performed may be different than the order described above, which is indicated by the dotted lines in the figure. If one or more of the steps are performed more times, the order of the steps may also be different.

Although some embodiments have been described and shown in detail, the invention is not restricted to them, but may also be embodied in other ways within the scope of the subject matter defined in the following claims. In particular, it is to be understood that other embodiments may be utilised and structural and functional modifications may be made without departing from the scope of the present invention.

In device claims enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims or described in different embodiments does not indicate that a combination of these measures cannot be used to advantage.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

The features of the method described above and in the following may be implemented in software and carried out on a data processing system or other processing means caused by the execution of computer-executable instructions. The instructions may be program code means loaded in a memory, such as a RAM, from a storage medium or from another computer via a computer network. Alternatively, the described features may be

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implemented by hardwired circuitry instead of software or in combination with software.

Literature:

C. Graetzel, T. Fong, S. Grange, and C. Baur. A Non-Contact Mouse for Surgeon-Computer Interaction. Technology and Health Care, 12(3), 2004.

Vogt S., Khamene A., Niemann H., Sauer F., An AR system with intuitive user interface for manipulation and visualization of 3D medical data. Stud. Health Technol. Inform. 2004;98, pp. 397-403.

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Claims:

1. A system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D environment is represented on the display.

2. The system according to any one or more of the preceding claims, wherein the view is defined as viewing angle and/or viewing position.

3. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for changing the rendering of the 3D environment on the display.

4. The system according to any one or more of the preceding claims, wherein the at least one action comprises one or more of:

- measuring,
- recording,
- scanning,
- manipulating, and/or
- modifying.

5. The system according to any one or more of the preceding claims, wherein the display is adapted to represent the 3D environment from multiple views.

6. The system according to any one or more of the preceding claims, wherein the view of the 3D environment represented in the at least one display is at

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least partly determined by the motion of the operator's hand holding said device.

7. The system according to any one or more of the preceding claims, wherein the magnification represented in the at least one display is at least partly determined by the motion of the operator's hand holding said device.

8. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

9. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises rendering of texture and/or shading.

10. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner.

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System with 3D user interface integration

Abstract

Disclosed is a system comprising a handheld device and at least one display, where the handheld device is adapted for performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and where the handheld device is adapted for remotely controlling the view with which the 3D environment is represented on the display.

(fig. 2a) should be published)

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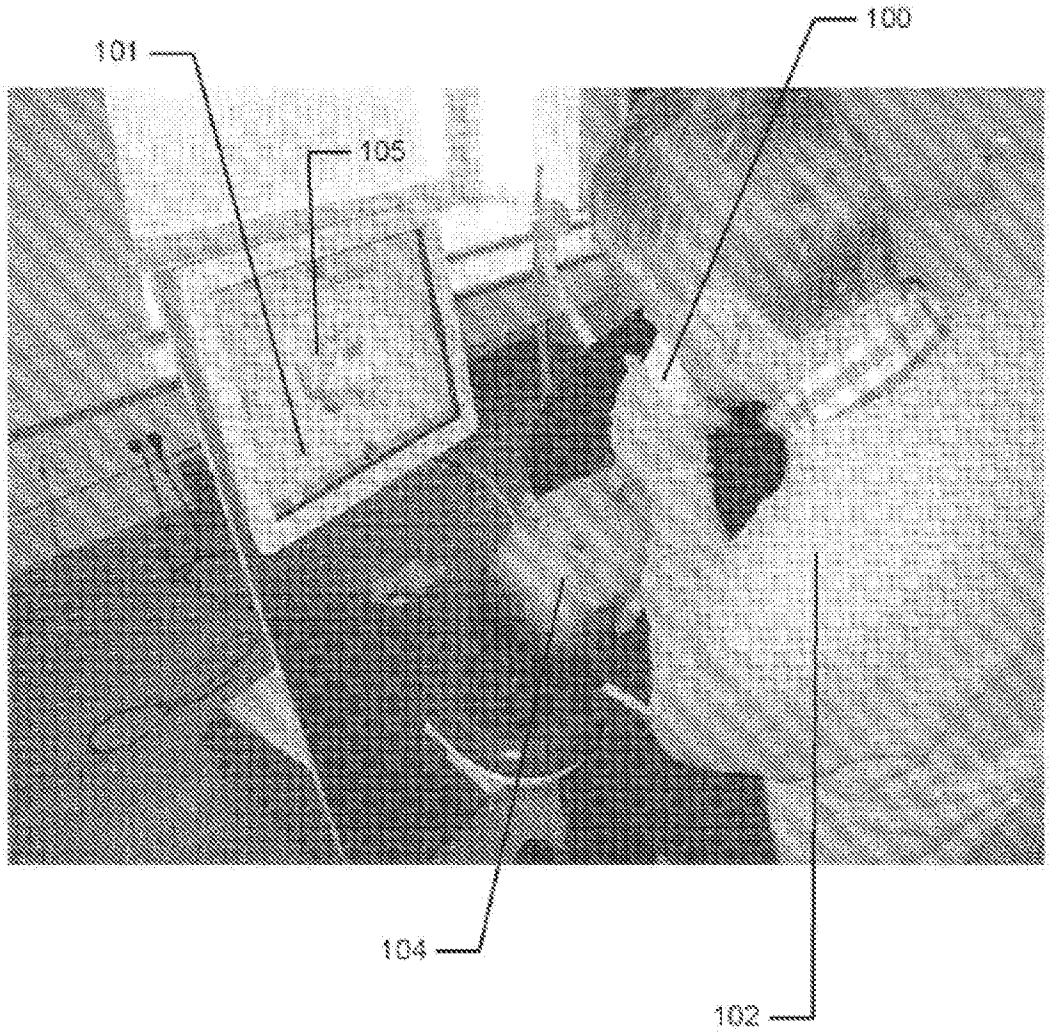


Fig. 1

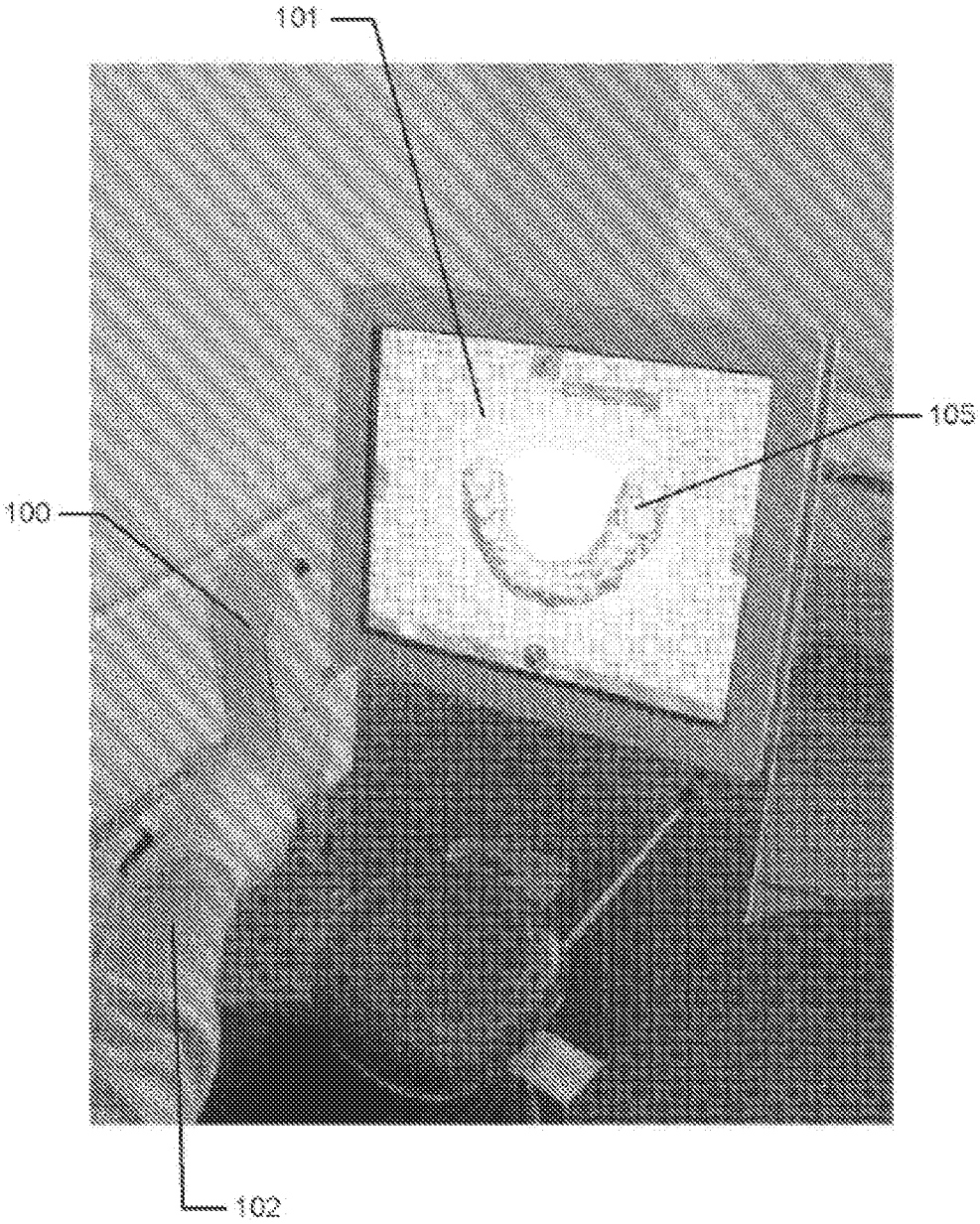


Fig. 2a)

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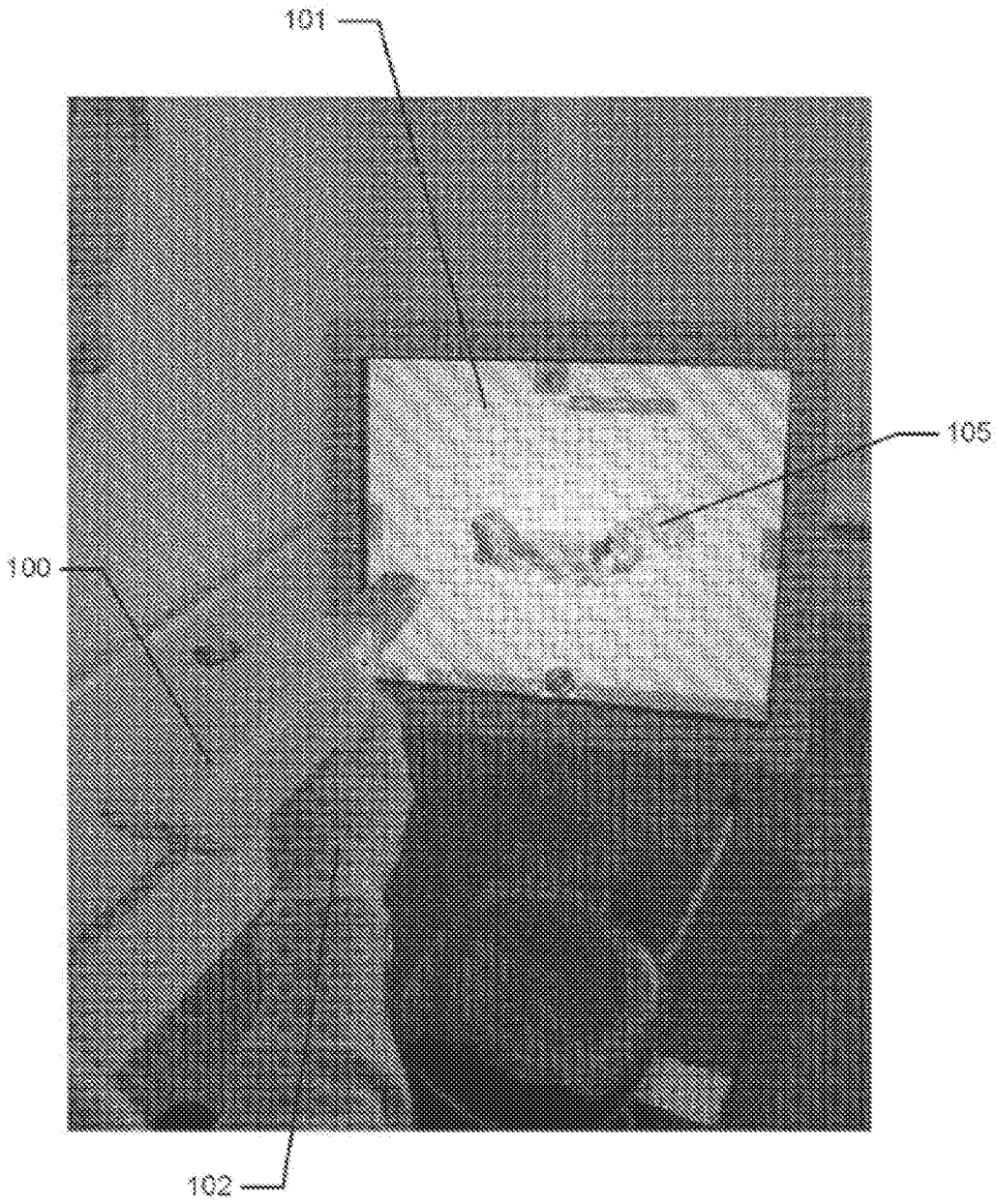


Fig. 2b)

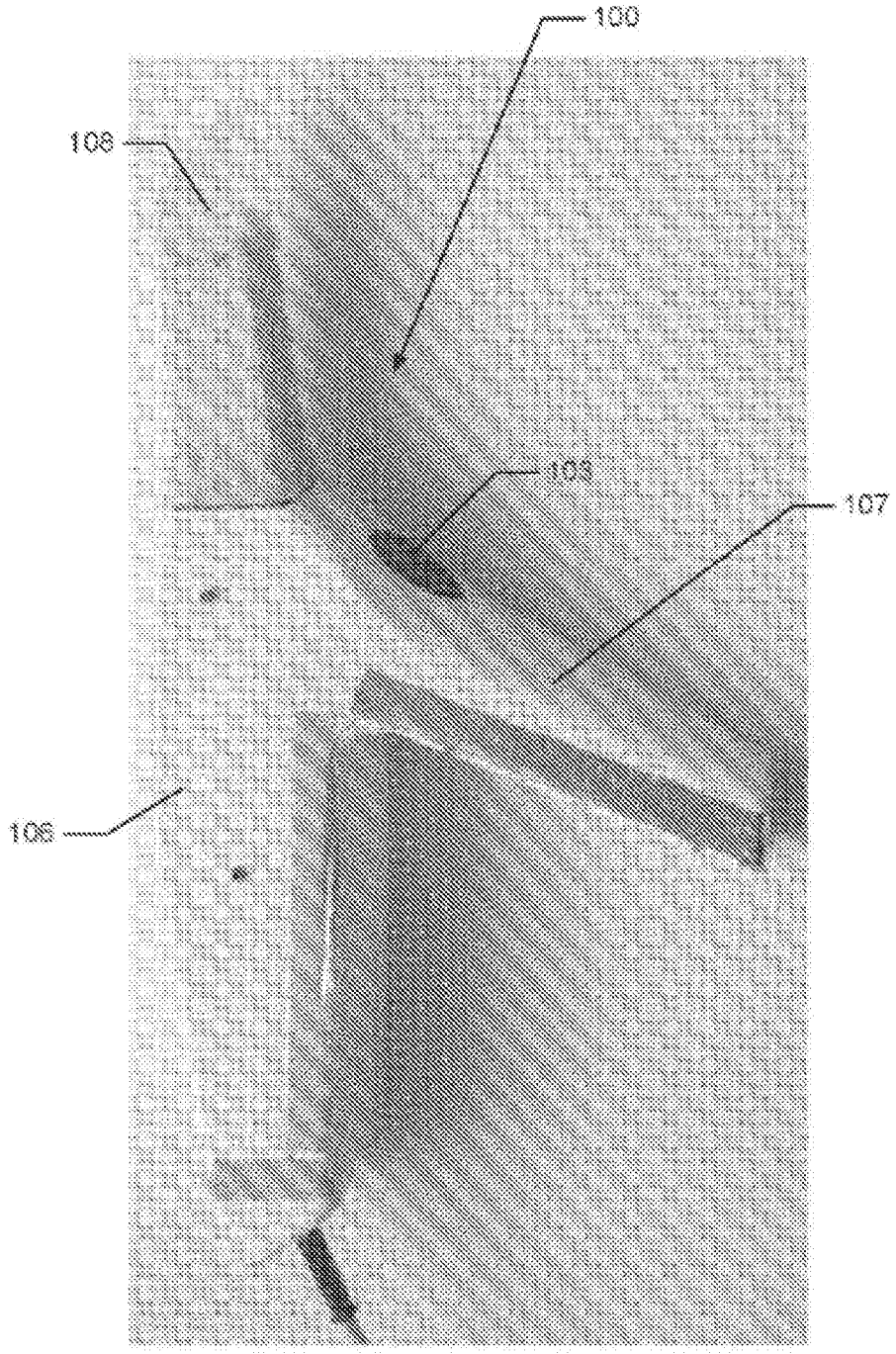


Fig. 3

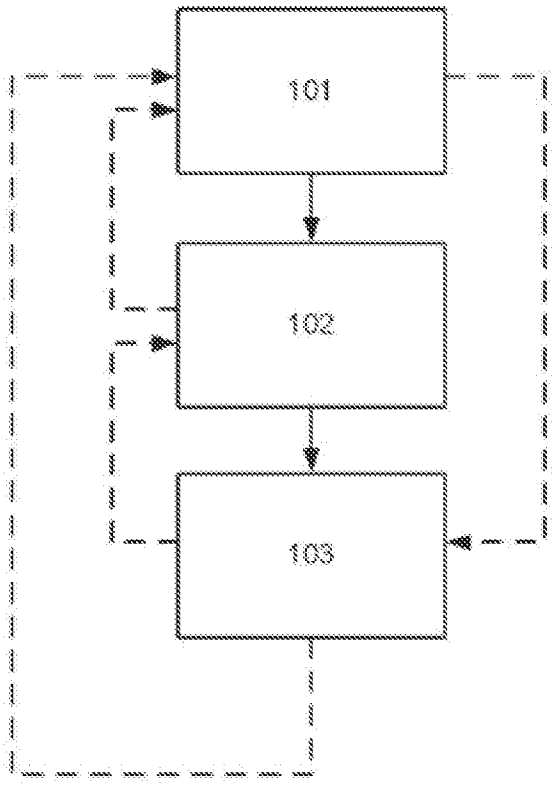


Fig. 4

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DENTAL IMAGING

Europäisches Patentamt
European Patent Office
Office européen des brevets

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Guardian IP Consulting I/S
Diplomvej, Building 381
DK-2800 Kgs. Lyngby
DANEMARK

For any questions about this communication:
Tel. +31 (0)70 340 45 00

Date
19.04.13

Reference	Application No./Patent No.
	11847582.1 - 1558 PCT/DK2011050461
Applicant/Proprietor:	
3Shape A/S	

Entry into the European phase before the European Patent Office

The following information describes the procedural steps required for entry into the European phase before the European Patent Office (EPO). You are advised to read it carefully because failure to take the necessary action in due time can lead to a loss of rights.

1. The above mentioned international patent application has been given the **European application No. 11847582.1**.

2. Applicants **without a residence or their principal place of business** in an EPC Contracting State may themselves initiate European processing of their international applications, provided they do so before expiry of the 31st month from the priority date.

   During the European phase before the EPO as designated or elected Office, however, such applicants **must** be represented by a professional representative (Art. 133(2) and Art. 134(1) and (8) EPC).

   Where, at the expiry of the time period laid down in Rule 163(5) EPC, the requirements of Article 133(2) EPC have not been complied with, the European patent application will be **refused**, pursuant to Rule 163(6) EPC.

   Please note that a professional representative authorised to act before the EPO and who acted for the applicant during the international phase does not automatically become the representative for the European phase. Applicants are therefore strongly advised to appoint in good time any representative they wish to initiate the European phase for them; otherwise the EPO has to send all communications directly to the applicant.

3. Applicants **with a residence or their principal place of business** in an EPC Contracting State are not obliged to appoint for the European phase a professional representative authorised to act before the EPO. However, in view of the complexity of the procedure it is recommended that they do so.

4. Applicants and professional representatives are also strongly advised to initiate the European phase using **EPO Form 1200**. It is available free of charge from the EPO or via the EPO website at **www.epo.org**. Similarly, it can be or generated with the Online Filing software, obtainable free of charge from the EPO (**www.epoline.org**) The use of the form is not compulsory.

5. Where the EPO acts as designated or elected Office (Art. 22(1) and (3) and 39(1) PCT), to enter the European phase before the EPO, the **following acts** must be performed by the applicant within **31 months** from the date of filing of the international application or (where applicable) the earliest priority date:

   a) Supply a translation of the international application into an EPO official language, if the International Bureau did not publish the application in such language (Art. 22(1) PCT and R. 159(1)(a) EPC);

   b) Specify the application documents, as originally filed or as amended, on which the European grant procedure is to be based (R. 159(1)(b) EPC);

   c) Pay the filing fee and, where applicable, the additional fee for a European patent application comprising more than 35 pages (R. 159(1)(c) EPC, Art. 2, items 1, 1a Rules relating to Fees);

   d) Pay the search fee where a supplementary European search report has to be drawn up (R. 159(1)(d) EPC);

   e) Pay the designation fee if the time limit laid down in Rule 39(1) EPC (i.e. six months after publication of the international search report) has expired before the 31-month period pursuant to Rule 159(1) EPC (R. 159(1)(d) EPC);

   f) File the written request for examination and pay the examination fee if the time limit laid down in Rule 70(1) EPC has expired before the 31-month period pursuant to Rule 159(1) EPC (R. 159(1)(f) EPC);

   g) Pay the renewal fee in respect of the third year, if the fee has fallen due (see Rule 51(1) EPC) before expiry of the 31-month period pursuant to Rule 159(1) EPC (R. 159(1)(g) EPC);

   h) File, where applicable, the certificate of exhibition referred to in Article 55(2) and Rule 25 EPC (R. 159(1)(h) EPC);

   i) Pay the claims fees for the sixteenth and each subsequent claim when the application documents on which the European grant procedure is to be based comprise more than fifteen claims (R. 162(1) EPC). For applications entering the European phase on or after 1 April 2009, a higher amount is payable for the 51st and each subsequent claim (Decision of the Administrative Council of 14 December 2007 amending the Rules relating to Fees, OJ EPO 2008, 10).

If either the translation of the international application or the request for examination is not filed in time, or if the filing fee, the additional fee, the search fee, the designation fee or the examination fee is not paid in due time, the application shall be deemed to be withdrawn (R. 160(1) EPC).

6. Payment of fees

An up-to-date guidance for the payment of fees, expenses and prices and a list of the euro accounts of the European Patent Organisation are published in each issue of the Official Journal of the EPO. The guidance includes inter alia a reference to the latest version of the Schedule of fees and expenses where the amounts of fees are set out.

The Schedule of fees and expenses, published as a Supplement to the Official Journal of the EPO, is also available on the EPO website (**www.epo.org**) and can be found under **www.epo.org/schedule-of-fees**, which allows the viewing, downloading and searching for individual fee amounts, both current and previous.

Applicants should always check the fee amounts applying at the time of payment.

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Payments can be validly made by any person. Permissible methods of payment are laid down in Article 5 Rules relating to Fees. Please note that payment cannot be made by cheque sent to the EPO.

For information on the calculation of the additional fee for applications comprising more than 35 pages, see Notice from the European Patent Office dated 26 January 2009 concerning the 2009 fee structure (OJ EPO 2009, 118), Notice supplementing the notice from the European Patent Office dated 26 January 2009 concerning the 2009 fee structure (OJ EPO 2009, 338) and Guidelines for Examination in the EPO, April 2010, A-III, 13.2.

For an overview of search and examination fees, see Notice from the European Patent Office dated 8 February 2010 (OJ EPO 2010, 133). Fee information is also published on the EPO website under **www.epo.org/fees**.

7. Restoration of priority right

Where the international application contains a priority claim to an earlier application and it has been filed within two months from the expiration of the 12-month priority period, a request for restoration before the EPO as designated Office (R. 49*ter*.2 PCT) applies under the following circumstances:

a) No request for restoration filed before the receiving Office (RO) during the international phase (R. 26*bis*.3 PCT)
b) Negative decision by the RO irrespective of the criterion applied (due care/ unintentionality)
c) Positive decision by the RO based on the unintentionality criterion.

For a request to be admissible, it must be filed and the requisite fee must be paid (R. 49*ter*.2(b)(iii) and R. 49*ter*.2(d) PCT) within one month from the applicable time limit under Article 22 PCT for entering the regional phase (R. 49*ter*.2(b)(i) PCT). The request for restoration also needs to state the reasons for the failure to file the international application within the priority period (Rule 49*ter*.2(b)(ii) PCT).

8. If the applicant had appointed a representative during the application's international phase, the present Form will be sent to the representative, asking him to inform the applicant accordingly.
All subsequent communications will be sent to the applicant, or - if the EPO is informed of his appointment in time - to the applicant's European representative.

9. For more details about time limits and procedural acts before the EPO as designated or elected Office, see the EPO brochure "How to get a European patent", Guide for applicants - Part 2, PCT procedure before the EPO - "Euro-PCT".
This brochure, the list of professional representatives before the EPO as well as Form 1200 are available on the Internet under **www.epo.org**.

Receiving Section

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Entry into the European phase (EPO as designated or elected Office)

To the European Patent Office

European application number	EP11847562.1
PCT application number	PCT/DK2011/050481
PCT publication number	WO2012078313
Applicant's or representative's reference	P1266EP00
International Filing Date	05.12.2011
International Searching Authority (ISA)	XN
International Preliminary Examining Authority (IPEA)	not applicable

1. Applicant

Indications concerning the applicant(s) are contained in the international publication or were recorded by the International Bureau after the international publication. ☒

Changes which have not yet been recorded by the International Bureau are set out here: ☐

2. Representative

This is the representative who will be listed in the Register of European Patents and to whom notifications will be made

Representative 1

Name:	Münzer, Mr Marc
Company:	Guardian IP Consulting I/S
Address of place of business:	Diplomvej, Building 381
	2800 Kgs. Lyngby
	Denmark
Telephone:	+45 70 27 53 63
Fax:	+45 70 27 53 62
e-mail:	mail@gipc.eu

3. Authorisation

An individual authorisation is attached. ☐

A general authorisation has been registered under No: ☐

A general authorisation has been filed, but not yet registered. ☐

The authorisation filed with the EPO as PCT receiving Office expressly includes the European phase. ☐

4. Request for examination

Examination of the application under Art. 94 EPC is hereby requested. The examination fee is being (has been, will be) paid. ☒

Request for examination in an admissible non-EPO language: ☒

Hermed begæres prøvning af ansøgningen i henhold til Art. 94.

The applicant waives his right to be asked under Rule 70(2) EPC whether he wishes to proceed further with the application. ☐

5. Copies

Additional copies of the documents cited in the supplementary European search report are requested. ☐

Number of additional sets of copies

6. Documents intended for proceedings before the EPO

Number of claims on entry into the European phase: 52

6.1 Proceedings before the EPO as designated Office (PCT I) are to be based on the following documents:

the application documents published by the International Bureau (with all claims, ☒

description and drawings), where applicable with amended claims under Art. 19 PCT

unless replaced by the amendments attached. ☐

Where necessary, clarifications should be attached as 'Other documents'

6.2 Proceedings before the EPO as elected Office (PCT II) are to be based on the following documents:

the documents on which the international preliminary examination report is based, including any annexes ☐

unless replaced by the amendments attached. ☐

Where necessary, clarifications should be attached as 'Other documents'

If the EPO as International Preliminary Examining Authority has been supplied with test reports, these may be used as the basis of proceedings before the EPO. ☐

6.3 A copy of the results of the search carried out by the authority with which the previous application(s) whose priority is claimed was (were) filed is attached (R. 141(1) EPC). ☐

6.4 The applicant waives his right to the communication under Rules 161(1) or (2) and 162 EPC. ☐

7. Translations

Translations in one of the official languages of the EPO (English, French, German) are attached as crossed below: ☐

** In proceedings before the EPO as designated or elected Office (PCT I + II):*

Translation of the international application (description, claims, any text in the drawings) as originally filed, of the abstract as published and of any indication under Rule 13bis.3 and 13bis.4 PCT regarding biological material ☐

Translation of the priority application(s) (to be filed only at the EPO's request, Rule 53(3) EPC) ☐

It is hereby declared that the international application as originally filed is a complete translation of the previous application (Rule 53(3) EPC) ☐

** In addition, in proceedings before the EPO as designated Office (PCT I):*

Translation of amended claims and any statement under Art. 19 PCT, if the claims as amended are to form the basis for the proceedings before the EPO (see Section 6). ☐

** In addition, in proceedings before the EPO as elected Office (PCT II):*

Translation of annexes to the international preliminary examination report ☐

8. Biological material

The invention uses and/or relates to biological material deposited under Rule 31 EPC. ☐

The particulars referred to in Rule 31(1)(c) EPC (if not yet known, the depositary institution and the identification reference(s)) (number, symbols, etc.) of the depositor) are given in the international publication or in the translation submitted in Section 7 on: ☐

page(s) / line(s)

The receipt(s) of deposit issued by the depositary institution

is (are) enclosed. ☐

will be filed later. ☐

Waiver of the right to an undertaking from the requester pursuant to Rule 33(2) EPC attached. ☐

9. Nucleotide and amino acid sequences

The international application discloses nucleotide and/or amino acid sequences. ☐

9.1 The sequence listing was filed under Rule 5.2(a) PCT, or furnished to the EPO as ISA under Rule 13ter.1(a) PCT, or is otherwise available to the EPO, in computer-readable format in accordance with WIPO ST.25. ☐

9.2

The sequence listing is attached in computer-readable format in accordance with WIPO Standard ST.25 ☐

The sequence listing is attached in PDF format. ☐

The sequence listing does not include matter which goes beyond the content of ☐

the application as filed.

10. Designation fees ☒

All the contracting states party to the EPC at the time of filing of the international patent application and designated in the international application are deemed to be designated (see Article 79(1) EPC).

The following states, which were contracting states to the EPC at the time of filing of the international application, are designated:

AL AT BE BG CH&LI CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

11. Extension of the European patent ☒

This application is deemed to be a request to extend the European patent application and the European patent granted in respect of it to all the non-contracting states to the EPC designated in the international application and with which extension agreements are in force on the date on which the international application is filed. However, the extension only takes effect if the prescribed extension fee is paid.

It is currently intended to pay the extension fee for the following states:

BA ME

Note: Under the automatic debiting procedure, extension fees will only be debited for states indicated here, unless the EPO is instructed otherwise before expiry of the period for payment.

12. List of enclosed documents

	Description of document	Original file name	Assigned file name

13. Mode of payment: Debit from deposit account ☒

Currency: EUR

The European Patent Office is hereby authorised, to debit from the deposit account with the EPO any fees and costs indicated on the fees page.

Deposit account number: 28030226

Account holder: Guardian IP Consulting I/S

14. Any refunds should be made to the following EPO deposit account: ☒

Number and account holder: Guardian IP Consulting I/S, 28030226

15. Fees

		Factor/reduction applied	Fee schedule	Amount to be paid
15-1	002 Fee for a European search - Applications filed on/after 01.07.2005	0.50	1 165.00	175.00
15-2	005a Designation fee - For all contracting States designated for applications filed on/after 01.04.2009	1	555.00	555.00
15-3	006 Examination fee - For applications filed on/after 01.07.2005	0.8	1 555.00	1 244.00
15-4	020 Filing fee - entry EP phase - online	1	115.00	115.00
15-5	520 Additional filing fee for the 36th and each subsequent page - entry into EP phase	11	14.00	154.00
	Total:		EUR	2 243.00

16. Annotations

17. Signature(s) of applicant(s) or representative

Place:	Copenhagen, Denmark
Date:	19 June 2013
Signed by:	OK, 3Shape A/S, M. Ninn-Pedersen 29502
Capacity:	(Applicant: 3Shape A/S)
Function of person signing:	Employee

P1266EP00

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Table for section 6 of Form 1200.3

In accordance with the Notice from the European Patent Office dated 28 January 2009 concerning the 2009 fee structure (OJ EPO 2009, 118, and Guidelines for Examination in the EPO, April 2009, A-III, 13.2), the amount of the additional fee (Art. 2, item 1a, Rules relating to Fees) for the pages of this European patent application is calculated as follows:

Documents intended for proceedings before the EPO (R. 159 (1) (b) EPC) and for calculating the additional fee (Art. 2, item 1a, RFees):

		Page(s) from ... to ...	Number of pages
Description:	International application as published	1-33	33
Claims:	International application as published	34-40	7
Drawings:	International application as published	1-5	5
Abstract:	Default count: one page		1
Total number of pages			46
Fee-exempt pages (Art. 2, item 1a, RFees)			-35
Number of pages to be paid for			11
			(x 14 EUR per page)
Total amount payable		EUR	154

Europäisches Patentamt
European Patent Office
Office européen des brevets

Acknowledgement of receipt

We hereby acknowledge receipt of the form for entry into the European phase (EPO as designated or elected Office) as follows:

Submission number	2179327
PCT application number	PCT/DK2011/050461
EP application number	11847682.1
Date of receipt	19 June 2013
Receiving Office	European Patent Office, The Hague
Your reference	P1266EP00
Applicant	
Country	
Documents submitted	package-data.xml ep-euro-pct.xml application-body.xml epf1200.pdf (4 p.)
Submitted by	CN=M. Ninn-Pedersen 29602,O=3Shape A/S,C=DK
Method of submission	Online
Date and time receipt generated	19 June 2013, 11:13 (CEST)
Message Digest	41:BD:5D:FB:49:3C:92:5E:81:45:6E:27:07:64:85:0B:86:C8:31:52

Correction by the EPO of errors in debit instructions filed by eOLF
Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44bis)

Applicant's or agent's file reference P1268PC00	FOR FURTHER ACTION	See item 4 below
International application No. PCT/DK2011/050461	International filing date *(day/month/year)* 05 December 2011 (05.12.2011)	Priority date *(day/month/year)* 06 December 2010 (06.12.2010)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant 3SHAPE A/S		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☒	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis*.2).

	Date of issuance of this report 12 June 2013 (12.06.2013)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Nora Lindner e-mail: pt03.pct@wipo.int

Form PCT/IB/373 (January 2004)

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PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
HØIBERG A/S
St. Kongensgade 59A
DK-1264 Copenhagen K
Denmark

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	22/02/2012
Applicant's or agent's file reference: P2635PC00	FOR FURTHER ACTION: See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/DK2011/050461	05/12/2011	08/12/2010

International Patent Classification (IPC) or both national classification and IPC
G01B 11/24 (2006.01), A61C 13/00 (2006.01)

Applicant 3SHAPE A/S

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/	Date of completion of this opinion	Authorized officer
Nordic Patent Institute, Helgeshøj Allé 81, DK-2630 Taastrup, Denmark Facsimile No. +45 43 50 80 08	20/02/2012	Lennart Bitsch Telephone No. +45 43 50 8244

Form PCT/ISA/237 (cover sheet) (July 2011)

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WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/DK2011/050461

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (*Rule 43bis.1(a)*)

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

a. (means)

☐ on paper

☐ in electronic form

b. (time)

☐ in the international application as filed

☐ together with the international application in electronic form

☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/DK2011/050481

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:
   - ☐ paid additional fees.
   - ☐ paid additional fees under protest and, where applicable, the protest fee.
   - ☐ paid additional fees under protest but the applicable protest fee was not paid.
   - ☒ not paid additional fees.
2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.
3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is
   - ☐ complied with.
   - ☒ not complied with for the following reasons:

This Authority found multible inventions.

US 2009/0217207 A1 (KAGERMEIER et al) 2009.08.27 describes a system comprising a handheld device (10) and at least one display (3, 22), where the handheld device is adapted for switching between
-performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment ([0013], [0037]), and
-remotely controlling the view with which the 3D environment is represented on the display ([0007], [0036], [0039])

The general concept described in the independent claim 1 is known from US 2009/0217207, and the application does therefore describe 4 inventions

A: Claims 2-34, 38-52 describe modifications of a system, a method, and a computer program product comprising a handheld device for performing at least one action, and for remotely controlling the view, and wherein the handheld device is an intra-oral 3D scanner
B: Claim 35 describes a system wherein the handheld device of claim 1 is a surgical instrument
C: Claim 36 describes a system wherein the handheld device of claim 1 is a mechanical tool
D: Claim 37 describes a system wherein the handheld device of claim 1 is an in-ear 3D scanner

There is no Single General Inventive Concept among the inventions A, B, C and D, and there is, therefore, not a technical relationship to link the invention as defined in Rules 13.1 and 13.2 PCT.

4. Consequently, this opinion has been established in respect of the following parts of the international application:
   - ☐ all parts.
   - ☒ the parts relating to claims Nos. 1-34, 38-52

Form PCT/ISA/237 (Box No. IV) (July 2011)

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WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/DK2011/050461

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	11, 16, 25, 30-31,34, 39, 43-44, 48-49	YES
	Claims	See Supplemental Box	NO
Inventive step (IS)	Claims	34, 49	YES
	Claims	1-33, 38-48, 50-52	NO
Industrial applicability (IA)	Claims	1-34, 38-52	YES
	Claims		NO

2. Citations and explanations:

D1: US 2009/0217207 A1 (KAGERMEIER et al) 2009.08.27 describes a system comprising a handheld device (10) and at least one display (3, 22), where the handheld device is adapted for switching between
-performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment ([0013], [0037]), and
-remotely controlling the view with which the 3D environment is represented on the display ([0007], [0036], [0039])
The handheld device is adapted to record 3D geometries of the environment (e.g. controlling a computer tomograph [0036]) and further comprises:
-means for switching between performing an action and controlling the view ([0012]),
-a motion sensor which can be used to move, rotate and scale the displayed image ([0007], [0009]-[0010], [0016], [0019]-[0020], [0023])

NOVELTY (Article 33(2) PCT)
The invention according to claims 1-10, 12-15, 17-24, 26-29, 32-33, 38, 40-42, 45-47 and 50-52 is described in D1, an this invention is therefore not novel.

INVENTIVE STEP (Article 33(3) PCT)
The additional subject matter of claims 11, 16, 25, 30-31, 39, 43-44, 48-48 all describe modifications that would be suggested by a skilled person who desires to adapt the system to support the working procedures of a user of the handheld device. The invention according to claims 11, 16, 25, 30-31, 39, 43-44, 48-48 does not involve an inventive step.

The invention according to claims 34 and 49 differs from D1 in that the handheld device is an intra-oral scanner, and the objective problem is to provide a system which easily enables an intra-oral scanning.

A person skilled in the art of developing scanning devices who desires to solve the above mentioned problem would not be inspired by his common or specialist knowledge in order to suggest the invention according to claims 34 and 49. Therefore, the invention according to claims 34 and 49 involves an inventive step.

INDUSTRIAL APPLICABILITY (Article 33(4) PCT)
The industrial applicability of the invention according to claims 1-34, 38-52 is evident.

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/DK2011/050461

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

The following claims refer to dependent claims where the preceding claims that they refer to, does not define the subject matter of that dependent claim, i.e., claim 13 refer to any one or more of the preceding claims eventhough the motion sensor only is defined in claim 12. These claims are therefore lacking clarity and does not comply with Article 6:
-claim 13 must refer to claim 12,
-claim 14 must refer to claim 6 or 12, and claims relating to this claim.
-claim 21 must refer to claim 20,
-claim 22 must refer to claim 18,
-claim 23 must refer to claim 22,
-claim 24 must refer to claim 22,
-claim 25 must refer to claim 22,
-claim 32 must refer to claims 2 or 15, and claims relating to these claims.
-claim 33 must refer to claims 2, 15 or 32, and claims relating to these claims.
-claim 41 must refer to claim 40,
-claim 42 must refer to claims 40-41,
-claim 43 must refer to claims 40-42,
-claim 44 must refer to claims 40-43,
-claim 45 must refer to claims 40-44,
-claim 47 must refer to claim 8, and claims relating to this claim.

The following claims are lacking clarity for various reasons:
-The subject matter of claim 15 is essentially the same as claim 2 and claim 15 appears redundant. Therefore, claim 15 does not comply with the requirement that the claims should be concise, see Rule 6.1(a), GL A5.42
-Claim 16 is not defined by technical features describing a system. The statement "wherein the 3D geometry of the 3D environment is known a-priori" is unclear and does not assist in defining the system, i.e., to know something is usually understood as an action performed by a person, see Rule 6.3(a).
The feature "Cart" in Claim 39 is not explained or supported in the description, and the claim does, therefore, not comply with Article 6.

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Box V

Claims1-10, 12-15, 17-24, 26-29, 32-33, 38, 40-42, 45-47, 50-52 are not novel.

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Date
10.07.13

Reference	Application No./Patent No.
	11847582.1 - 1558 PCT/DK2011050461
Applicant/Proprietor	
3Shape A/S	

Notification of the data mentioned in Rule 19(3) EPC

In the above-identified patent application you are designated as inventor/co-inventor.
Pursuant to Rule 19(3) EPC the following data are notified herewith:

DATE OF FILING	: 05.12.11
PRIORITY	: DK/06.12.10/ DKA 201001104 : US/06.12.10/ USP 420138
TITLE	: SYSTEM WITH 3D USER INTERFACE INTEGRATION
DESIGNATED STATES	: AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

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Exhibit 1004 page 1123 of 1621
DENTAL IMAGING

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Reference	Application No./Patent No.
	11847582.1 - 1558 PCT/DK2011050461
Applicant/Proprietor	
3Shape A/S	

Notification of the data mentioned in Rule 19(3) EPC

In the above-identified patent application you are designated as inventor/co-inventor.
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Exhibit 1004 page 1124 of 1621
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Reference	Application No./Patent No.
	11847582.1 - 1558 PCT/DK2011050461
Applicant/Proprietor	
3Shape A/S	

Notification of the data mentioned in Rule 19(3) EPC

In the above-identified patent application you are designated as inventor/co-inventor.
Pursuant to Rule 19(3) EPC the following data are notified herewith:

DATE OF FILING	: 05.12.11
PRIORITY	: DK/06.12.10/ DKA 201001104 : US/06.12.10/ USP 420138
TITLE	: SYSTEM WITH 3D USER INTERFACE INTEGRATION
DESIGNATED STATES	: AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

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Date
12.07.13

Reference	Application No / Patent No
P1266EP00	11847582.1 - 1558 PCT/DK2011050461
Applicant/Proprietor	
3Shape A/S	

Communication pursuant to Rules 161(2) and 162 EPC

1. Amendment of the application (R. 161(2) EPC)

The above-mentioned international (Euro-PCT) application has entered the European phase.

Under Articles 28, 41 PCT and Rules 52, 79 PCT the application may be amended before a designated or elected Office.

In accordance with Rule 161(2) EPC, you may amend your application once within a **non-extendable period of six months** after notification of the present communication.

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the Examining Division requesting that you correct this deficiency (R. 137(4) EPC).

The claims applicable on expiry of this period, i.e. those filed on entry into the European phase or in response to the present communication, will form the basis for the calculation of any claims fee to be paid (see page 2).

-2-

Registered letter

Exhibit 1004 page 1126 of 1621
DENTAL IMAGING

2 Claims fees under Rule 162 EPC

If the application documents on which the European grant procedure is to be based comprise more than fifteen claims, a claims fee shall be payable for the sixteenth and each subsequent claim within the period provided for in Rule 159(1) EPC.

☐ Based on the application documents currently on file, all necessary claims fees have already been paid (or the documents do not comprise more than 15 claims).

☐ All necessary fees will be/have been debited automatically according to the automatic debit order.

☑ The claims fees due for the claims 16 to 52 were not paid within the above-mentioned period.

Any outstanding claims fee, either based on the current set of claims or on any amended claims to be filed pursuant to Rule 161 EPC (see page 1), may still be validly paid within a **non-extendable period of six months** after notification of this communication (R. 162(2) EPC).

If a payment is made for only some of the claims, you must indicate for which claims it is intended. If a claims fee is not paid in due time, the claim concerned is deemed to be abandoned (R. 162(4) EPC).

If claims fees have already been paid, but on expiry of the above-mentioned period there is a new set of claims containing fewer fee-incurring claims than before, the claims fees in excess of those due under Rule 162(2), second sentence EPC will be refunded (R. 162(3) EPC).

You are reminded that the supplementary search carried out according to Article 153(7) EPC will relate only to the last set of claims applicable on expiry of the above period AND will be confined to those fee-incurring claims for which fees have been paid in due time.

The claims fee is currently

EUR 225 for the 16th and each subsequent claim up to the limit of 50
EUR 585 for the 51st and each subsequent claim

Note to users of the automatic debiting procedure
Unless the EPO receives prior instructions to the contrary, the fees for all claims incurring fees will be debited on the last day of the period for payment. For further details see the Arrangements for the automatic debiting procedure, Supplement to OJ EPO 3/2009.

Important information concerning fee amounts
Following any amendment to the Rules relating to Fees, the amount(s) mentioned in this communication may be different from the amount(s) **actually due on the date of payment**. The latest version of the Schedule of fees and expenses, published as a Supplement to the Official Journal of the EPO, is also available on the EPO website (**www.epo.org**) and can be found under **www.epo.org/schedule-of-fees**, which allows the viewing, downloading and searching for individual fee amounts, both current and previous.

Payments by cheque delivered or sent direct to the EPO are no longer accepted as from 1 April 2008 (see OJ EPO 2007, 626).

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Exhibit 1004 page 1127 of 1621
DENTAL IMAGING

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Date
18.09.13

Reference	Application No / Patent No
P1266EP00	11847582.1 - 1558 / 2649409 PCT/DK2011050461
Applicant/Proprietor	
3Shape A/S	

Communication of European publication number and information on the application of Article 67(3) EPC

The provisional protection under Article 67(1) and (2) EPC in the individual Contracting States becomes effective only when the conditions referred to in Article 67(3) EPC have been fulfilled (for further details, see information brochure of the European Patent Office "National Law relating to the EPC" and additional information in the Official Journal of the European Patent Office).

Pursuant to Article 153(3) EPC the publication under Article 21 PCT of an international application for which the European Patent Office is a designated or elected Office takes the place of the publication of a European patent application.

The bibliographic data of the above-mentioned Euro-PCT application will be published on 16.10.13 in Section I.1 of the European Patent Bulletin. The European publication number is 2649409.

In all future communications to the European Patent Office, please quote the application number plus Directorate number.

Receiving Section

Letter accompanying subsequently filed items

Representative:
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The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number	11847552.1
Applicant's or representative's reference	P1268EP00

	Description of document	Original file name	Assigned file name
1	Letter relating to the search and examination procedure	Response to 161-162 - P1268EP00.pdf	EPLETT-1.pdf
2	Amended claims (clean copy)	20140016EP Claim reduction for 161_162 - Clean copy.pdf	CLMS-1.pdf
3	Amended claims with annotations	20140016EP Claim reduction for 161_162 - Marked-up.pdf	CLMS-HWA-1.pdf

Signatures

Place:	Copenhagen, Denmark
Date:	21 January 2014
Signed by:	OK, 3Shape A/S, J. Jensen 31081
Capacity:	(Applicant: 3shape A/S)
Function of person signing:	Patent agent

Guardian

Intellectual Property Consulting

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15 January 2014

Your ref.:
Our ref.: P1286EP00

European Patent Application No. 11847582.1
Applicant: 3Shape A/ S

Dear Madam/Sir

In response to communication under Rules 161(2) and 162 EPC dated 12 July 2013, we hereby forward a reduced set of claims, both a marked-up copy and a clean copy.

Kind regards
Guardian IP Consulting I/S

Mark Münzer
European patent attorney
Phone No.: +45 77 34 44 72

Exhibit 1004 page 1130 of 1621
DENTAL IMAGING

Claims

1. A system comprising a handheld device and at least one display, where the handheld device is adapted for switching between

- performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and
- remotely controlling the view with which the 3D environment is represented on the display.

2. A system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

3. A system according to any one or more of the preceding claims, wherein means for manually switching between performing the at least one action and remotely controlling the view is provided on the handheld device.

~~4. A system according to claim 3, wherein the means for manually switching is an actuator, such as a button, a switch or a contact.~~

~~5. The system according to any one or more of the preceding claims, wherein the view is defined as viewing angle and/or viewing position.~~

~~6. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for remotely controlling the magnification with which the 3D environment is represented on the display.~~

~~7. The system according to any one or more of the preceding claims, wherein the handheld device is adapted for changing the rendering of the 3D environment on the display.~~

Exhibit 1004 page 1131 of 1621
DENTAL IMAGING

84. The system according to any one or more of the preceding claims, wherein the at least one action comprises one or more of:

- measuring,
- recording,
- scanning,
- manipulating, and/or
- modifying.

~~9. The system according to any one or more of the preceding claims, wherein the 3D environment comprises one or more 3D objects.~~

~~10. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to be held in one hand by an operator.~~

~~11. The system according to any one or more of the preceding claims, wherein the display is adapted to represent the 3D environment from multiple views.~~

485. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one motion sensor.

486. The system according to any one or more of the preceding claims, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor.

~~14. The system according to any one or more of the preceding claims, wherein the magnification represented in the at least one display is at least partly determined by the at least one motion sensor.~~

~~15. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.~~

~~16. The system according to any one or more of the preceding claims, wherein the 3D geometry of the 3D environment is known a-priori.~~

~~17. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user interface element.~~

~~18. The system according to any one or more of the preceding claims, wherein the at least one user interface element is at least one motion sensor.~~

~~19. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least two motion sensors providing sensor fusion.~~

20. The system according to any one or more of the preceding claims, wherein the user interface functionality comprises the use of gestures.

~~21. The system according to any one or more of the preceding claims, wherein the gestures are detected by the at least one motion sensor.~~

~~22. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one user interface element other than the at least one motion sensor.~~

~~23. The system according to any one or more of the preceding claims, wherein the at least one other user interface element is a touch sensitive element.~~

24. The system according to any one or more of the preceding claims, wherein the at least one other user interface element is a button.

25. The system according to any one or more of the preceding claims, wherein the at least one other user interface element is a scroll wheel.

26. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing angle with which the 3D environment is represented on the at least one display.

27. The system according to any of the preceding claims, wherein the handheld device is adapted to change a magnification factor with which the 3D environment is represented on the at least one display.

28. The system according to any one or more of the preceding claims, wherein the handheld device is adapted to change a viewing position with which the 3D environment is represented on the at least one display.

29. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises a viewing angle, a magnification factor, and/or a viewing position.

30. The system according to any one or more of the preceding claims, wherein the view of the 3D environment comprises rendering of texture and/or shading.

31. The system according to any one or more of the preceding claims, wherein the at least one display is divided into multiple regions, each showing the 3D environment with a different view.

Exhibit 1004 page 1134 of 1621
DENTAL IMAGING

~~32. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D surface of the environment.~~

~~33. The system according to any one or more of the preceding claims, wherein the 3D geometry comprises a 3D volumetric representation of the environment.~~

348. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner.

~~35. The system according to any one or more of the preceding claims, wherein the handheld device is a surgical instrument.~~

~~36. The system according to any one or more of the preceding claims, wherein the handheld device is a mechanical tool.~~

379. The system according to any one or more of the preceding claims, wherein the handheld device is an in-ear 3D scanner.

~~38. The system according to any one or more of the preceding claims, wherein the at least one display is arranged separate from the handheld device.~~

~~39. The system according to any one or more of the preceding claims, wherein the at least one display is arranged on a cart.~~

4010. The system according to any one or more of the preceding claims, wherein the at least one display is defined as a first display, and where the system further comprises a second display.

Exhibit 1004 page 1135 of 1621
DENTAL IMAGING

~~41. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device.~~

~~42. The system according to any one or more of the preceding claims, wherein the second display is arranged on the handheld device in a position such that the display is adapted to be viewed by the operator, while the operator is operating the handheld device.~~

4311. The system according to any one or more of the preceding claims, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

4412. The system according to any one or more of the preceding claims, wherein the first display and/or the second display provides instructions for the operator.

~~45. The system according to any one or more of the preceding claims, wherein visual information is provided to the operator on one or more means other than the first display.~~

4613. The system according to any one or more of the preceding claims, wherein audible information to the operator is provided to the operator.

~~47. The system according to any one or more of the preceding claims, wherein the scanning is performed by means of LED scanning, laser light scanning, white light scanning, X-ray scanning, and/or CT scanning.~~

~~48. The system according to any one or more of the preceding claims, wherein a graphical pointer is provided on the display for representing the movement of the handheld device when the handheld device is used to~~

remotely controlling the view with which the 3D environment is represented on the display.

4914. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner and the at least one action performed in the physical 3D environment is scanning and that the view is remotely controlled by at least one motion sensor arranged in the handheld device, and wherein an actuator provided on the handheld device switches between performing the at least one action and remotely controlling the view.

50. A method of interaction between a handheld device and at least one display, where the method comprises the steps of:

performing at least one action in a physical 3D environment by means of the handheld device;

visually representing the physical 3D environment by the at least one display; and

remotely controlling the view of the represented 3D environment on the display by means of the handheld device.

51. A computer program product comprising program code means for causing a data processing system to perform the method of claim 44, when said program code means are executed on the data processing system.

52. A computer program product according to the previous claim, comprising a computer readable medium having stored there on the program code means.

Exhibit 1004 page 1137 of 1621
DENTAL IMAGING

Claims

1. A system comprising a handheld device and at least one display, where the handheld device is adapted for switching between
- performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment, and
- remotely controlling the view with which the 3D environment is represented on the display.

2. A system according to any one or more of the preceding claims, wherein the handheld device is adapted to record the 3D geometry of the 3D environment.

3. A system according to any one or more of the preceding claims, wherein means for manually switching between performing the at least one action and remotely controlling the view is provided on the handheld device.

4. The system according to any one or more of the preceding claims, wherein the at least one action comprises one or more of:
- measuring,
- recording,
- scanning,
- manipulating, and/or
- modifying.

5. The system according to any one or more of the preceding claims, wherein the handheld device comprises at least one motion sensor.

Exhibit 1004 page 1138 of 1621
DENTAL IMAGING

6. The system according to any one or more of the preceding claims, wherein the view of the 3D environment represented in the at least one display is at least partly determined by the at least one motion sensor.

7. The system according to any one or more of the preceding claims, wherein the user interface functionality comprises the use of gestures.

8. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner.

9. The system according to any one or more of the preceding claims, wherein the handheld device is an in-ear 3D scanner.

10. The system according to any one or more of the preceding claims, wherein the at least one display is defined as a first display, and where the system further comprises a second display.

11. The system according to any one or more of the preceding claims, wherein the second display indicates where the handheld device is positioned relative to the 3D environment.

12. The system according to any one or more of the preceding claims, wherein the first display and/or the second display provides instructions for the operator.

13. The system according to any one or more of the preceding claims, wherein audible information to the operator is provided to the operator.

14. The system according to any one or more of the preceding claims, wherein the handheld device is an intra-oral 3D scanner and the at least one action performed in the physical 3D environment is scanning and that the

Exhibit 1004 page 1139 of 1621
DENTAL IMAGING

view is remotely controlled by at least one motion sensor arranged in the handheld device, and wherein an actuator provided on the handheld device switches between performing the at least one action and remotely controlling the view.

Exhibit 1004 page 1140 of 1621
DENTAL IMAGING



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By fax : +49 89 2399 -4465

17 February 2015

Our ref.: Authorization of Association No. 373

Change of Representative to Guardian IP Consulting I/S – Association No. 373

Dear Sirs

Guardian IP Consulting I/S is registered as an Association under No. 373.

Please be advised that

Guardian IP Consulting I/S
(Association No. 373)
Diplomvej, Building 381
DK-2800 Kgs. Lyngby
Denmark

is hereby authorized to act on behalf of the Applicants of the European patent applications mentioned in the enclosed list in all future proceedings before the European Patent Office.

We therefore ask you kindly to transfer all the mentioned files from the individual representatives to Guardian IP Consulting I/S - Association No. 373.

Please note that we enclose the list of European patent applications in two versions, one sorted by Applicant and one sorted by Application Nos.

Thank you in advance.

Yours sincerely
Guardian IP Consulting I/S
(Association 373)

Steen Østergaard
European Patent Attorney
Tel.: +45 77 34 44 85

Encl.:

- List of EP patent applications to be transferred to Association 373 as representative (sorted by Applicant)
- List of EP patent applications to be transferred to Association 373 as representative (sorted by Application Nos.)

Duration: 17.02.2015 16:30:29 - 17.02.2015 16:33:08. This page 3 of 18 was completed at 17.02.2015 16:30:38.

Exhibit 1004 page 1142 of 1621
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Questions about this communication ?
Contact Customer Services at www.epo.org/contact

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Date
24.02.15

Reference	Application No / Patent No
P1266EP00	11847582.1 - 1558 / 2649409
Applicant/Proprietor	
3Shape A/S	

Communication of amended entries concerning the representative (R. 143(1)(h) EPC)

As requested, for the above-mentioned European patent application / European patent the entries concerning the representative have been amended as follows:

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DK

The amendment will be recorded in the Register of European Patents.

Receiving Section

Application No.: 11847582.1

The search has started on 09.03.17 (see Notice from the European Patent Office dated 03/2013, OJ EPO 2013, 163).

Receiving Section

Exhibit 1004 page 1144 of 1621
DENTAL IMAGING

SUPPLEMENTARY EUROPEAN SEARCH REPORT

Application Number
EP 11 84 7582

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,P Y,P	WO 2011/120526 A1 (3SHAPE AS [DK]; VAN DER POEL MIKE [DK]; HOLLENBECK KARL-JOSEF [DK]; FI) 6 October 2011 (2011-10-06) * abstract * * page 1, line 4 - line 28 * * page 23, line 7 - page 24, line 6 * * page 29, line 18 - page 30, line 2; figures 1-4 * * page 39, line 27 - page 40, line 5 *	1-9,13, 14 10-12	INV. G01B11/24 A61C9/00 A61B5/00 G06F3/01 G06F3/0346 G06F3/0481
X Y	US 2007/172112 A1 (PALEY ERIC B [US] ET AL) 26 July 2007 (2007-07-26) * paragraphs [0003], [0009], [0010] * * paragraph [0028] - paragraph [0043]; figures 1-5 * * paragraph [0070] - paragraph [0080]; figures 8,9 *	1-4,8,9 10-12	
X	US 2007/078340 A1 (WILCOX STEPHEN D [US] ET AL) 5 April 2007 (2007-04-05) * abstract * * paragraph [0001] - paragraph [0005] * * paragraph [0041] - paragraph [0080]; figures 1-10 *	1-7,13	TECHNICAL FIELDS SEARCHED (IPC) G01B G06F A61B A61C
X	US 2010/231509 A1 (BOILLOT MARC [US] ET AL) 16 September 2010 (2010-09-16) * abstract * * paragraph [0015] - paragraph [0033]; figures 1-5 *	1,3-7	
Y	US 2008/063998 A1 (LIANG RONGGUANG [US] ET AL) 13 March 2008 (2008-03-13) * paragraph [0122] - paragraph [0128]; figures 15-18 *	10-12	

-/--

The supplementary search report has been based on the last set of claims valid and available at the start of the search.

Place of search	Date of completion of the search	Examiner
Munich	16 March 2017	Burkart, Johannes

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503 03.82 (P04C01)

SUPPLEMENTARY EUROPEAN SEARCH REPORT

Application Number
EP 11 84 7582

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 6 361 489 B1 (TSAI JORY [US]) 26 March 2002 (2002-03-26) * abstract * * column 3, line 15 - line 53; figures 1-3 * * * column 5, line 5 - column 6, line 4; figures 3, 4 * -----	10-12	

TECHNICAL FIELDS SEARCHED (IPC)

The supplementary search report has been based on the last set of claims valid and available at the start of the search.

Place of search	Date of completion of the search	Examiner
Munich	16 March 2017	Burkart, Johannes

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO. EP 11 84 7582

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

16-03-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011120526 A1	06-10-2011	EP 2568870 A1	20-03-2013
		US 2013027515 A1	31-01-2013
		WO 2011120526 A1	06-10-2011
US 2007172112 A1	26-07-2007	EP 1979877 A2	15-10-2008
		EP 1984875 A1	29-10-2008
		EP 2327372 A1	01-06-2011
		EP 2918240 A1	16-09-2015
		JP 2009523552 A	25-06-2009
		US 2007172101 A1	26-07-2007
		US 2007172112 A1	26-07-2007
		US 2008199829 A1	21-08-2008
		US 2009298017 A1	03-12-2009
		US 2012231421 A1	13-09-2012
		US 2016051348 A1	25-02-2016
		WO 2007084647 A2	26-07-2007
		WO 2007084727 A1	26-07-2007
US 2007076340 A1	05-04-2007	NONE	
US 2010231589 A1	16-09-2010	NONE	
US 2008063998 A1	13-03-2008	CN 101520116 A	09-09-2009
		EP 2061372 A1	27-05-2009
		HK 1133170 A1	14-12-2012
		US 2008063998 A1	13-03-2008
		US 2012237890 A1	20-09-2012
		US 2013302746 A1	14-11-2013
		US 2015245770 A1	03-09-2015
		WO 2008033218 A1	20-03-2008
US 6361489 B1	26-03-2002	AU 1830800 A	13-06-2000
		EP 1151176 A1	12-12-2001
		US 6361489 B1	26-03-2002
		WO 0030526 A1	02-06-2000

EPO FORM P0459

Information on Search Strategy - Pilot phase (see OJ 2015, A66)
The type of information contained in this sheet may change during the pilot for improving the usefulness of this new service.

Application Number
EP 11 84 7582

TITLE: SYSTEM WITH 3D USER INTERFACE INTEGRATION

APPLICANT: 3Shape A/S

IPC CLASSIFICATION: G01B11/24, A61C9/00, A61B5/00, G06F3/01, G06F3/0346, G06F3/0481

EXAMINER: Burkart, Johannes

CONSULTED DATABASES: ANSERA, COMBI, DOSYS, EPODOC, INET, NPL, WPI

CLASSIFICATION SYMBOLS DEFINING EXTENT OF THE SEARCH:

IPC:

CPC: G01B11/24, G06F3/017, G06F3/0346, G06F3/04815, G01B9/02054, A61B1/00172, A61B1/227, A61B5/0088, A61B6/145

FI/F-TERMS:

KEYWORDS OR OTHER ELEMENTS FEATURING THE INVENTION:
A system comprising a handheld device (e.g. an in-ear/intra-oral 3D scanner) and a display for providing a visual representation of the 3D environment of the handheld device, wherein a user interface functionality for remotely controlling the view on the display is integrated into said handheld device, and wherein said handheld device can be switched between performing an action in the environment and remotely controlling the view.

Important concepts:
- Handheld 3D scanner (e.g. for medical applications)
- Display for visualization of 3D environment
- Remote display control by means of the handheld device (e.g. through motion or gesture sensing)
- Manual switching between action (e.g. scanning) and display controlling operation modes

Exhibit 1004 page 1148 of 1621
DENTAL IMAGING

The examination is being carried out on the **following application documents**

Description, Pages

1-33 as published

Claims, Numbers

1-14 filed in electronic form on 21-01-2014

Drawings, Sheets

1/5-5/5 as published

Reference is made to the following documents; the numbering will be adhered to in the rest of the procedure.

D1 WO 2011/120526 A1 (published in the priority interval)

D2 US 2007/172112 A1

D3 US 2007/078340 A1

D4 US 2009/217207 A1 (cited in the International Search Report)

D5 US 2010/231509 A1

D6 US 2008/063998 A1

D7 US 6 361 489 B1

1 **Priority**

The priority claim of the present application is **invalid**, as the two previous applications whose priority is claimed do **not disclose the same invention** as that claimed in the present set of claims, and the requirements of **Article 87(1) EPC** are therefore not met.

Specifically, the features of *switching between performing at least one action and remotely controlling the view* of independent claim 1 and the *(manual) actuator therefor* of claims 3 and 14 cannot be directly and unambiguously derived from said two previous applications by a skilled person.

Consequently, in accordance with **Articles 88(3), 88(4) and 89 EPC**, the international filing date of the present application is the relevant date of the present claims for the purposes of **Articles 54(2) and (3) EPC**.

2 Novelty

The present application does not meet the requirements of **Article 52(1) EPC** because the subject-matter of the following claims is **not new** within the meaning of **Article 54(1) and (2) EPC**.

2.1 Independent apparatus claim 1

2.1.1 **D1** discloses a system comprising a handheld device (fig.1: handheld in-ear 3D scanner 102; see p.1,l.4-8 and p.29,l.18-p.30,l.2]) and at least one display (p.23,l.28-p.24,l.2: computer screen), where the handheld device is adapted for switching (p.29,l.20-21: by means of scan button 104) between

a. performing at least one action (3D in-ear scanning) in a physical 3D environment (p.29,l.18-p.30,l.2), where the at least one display is adapted for visually representing the physical 3D environment (p.23,l. 28-p.24,l.2), and

b. remotely controlling the view with which the 3D environment is represented on the display (p.23,l.28-p.24,l.2).

Consequently, the subject-matter of claim 1 is not new.

2.1.2 **D2** also discloses a system (fig.1; [0028]) comprising a handheld device (handheld intraoral 3D scanner 102; cf. [0029],[0030]) and at least one display (110), where the handheld device is adapted for switching ([0030]: switch on scanner 102 for starting and stopping scans) between

a. performing at least one action in a physical 3D environment ([0029], [0030]: 3D intraoral scanning), where the at least one display is adapted for visually representing the physical 3D environment ([0039]), and

b. remotely controlling the view with which the 3D environment is represented on the display ([0077]: in one embodiment, navigational controls are located on the scanner to [remotely] rotate, pan or zoom the visual representation on the display).

Consequently, **D2** is also prejudicial to the novelty of claim 1.

2.1.3 For the sake of completeness, it is further noted that each one of **D3**, **D4** and **D5** is also prejudicial to the novelty of claim 1:

2.1.3.1 **D3** discloses a system (abstract) comprising a handheld ultrasound 3D scanner (fig.1: 12; see [0055]) adapted for switching (figs.6b,7; [0071]-[0073]; [0079],[0080]) to remotely controlling the view ([0062]: image orientation inversion) on a display (22) by means of gesture recognition (figs.5-7) using motion sensors (accelerometers 13,17) integrated in the scanner ([0058]).

2.1.3.2 **D4** discloses a system (abstract; fig.1) with a handheld remote control (10) comprising switches for remotely controlling the view of a medical image on a display (20; see figs.2,3) as well as the operation of a medical diagnostic or therapeutic unit ([0012],[0013]; [0035]-[0039]).

2.1.3.3 **D5** discloses a system (abstract; fig.1c) with a handheld surgical tool (139) in a sterile surgical field adapted for switching ([0025]) to remotely controlling the view (figs.2-5) on a computer display (150) outside the sterile field by means of an integrated gesture recognition interface ([0020]).

2.2 **Dependent claims 2-10, 13 and 14**

The subject-matter of the following dependent claims is disclosed in at least one of **D1**, **D2**, **D3**, **D4** and **D5**. One example is given below for each claim:

2.2.1 **Claims 2-4 and 8:** [0029],[0030] of **D2**: intraoral 3D scanner comprising a manual switching button

2.2.2 **Claims 5-7:** disclosed in **D3** (see item 2.1.3.1 above)

2.2.3 **Claim 9:** [0032] of **D2**: alternative embodiment of acquiring a 3D model for custom fitting of a hearing aid, i.e. in-ear 3D scanning

2.2.4 **Claim 10:** Fig.2 of **D4**: second display 22 on remote control 10

2.2.5 **Claim 13:** [0073] of **D3**

2.2.6 **Claim 14:** disclosed in **D1**: intra-oral 3D scanning embodiment [p.40,l.1-5], motion sensors for remotely controlling the view [p.23,l.7-11 and p.23,l.28-p.24,l.6], switching actuator on the scanner [fig.1;p.29,l.20-21: scan button 104]

3 **Inventive step - other dependent claims**

Claims 11 and 12 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of **Articles 52(1) and 56 EPC** with respect to inventive step:

Providing an additional integrated display on a handheld medical imaging device as a navigation aid is known in the art, for instance from **D6** or **D7** (see the cited passages). For visualizations providing real-time feedback and guidance (i.e. visual instructions) for the operator, see [0043] of **D2**.

4 Clarity

The requirements of **Article 84 EPC** are not met for the following reasons:

4.1 Claim 7

It is unclear to which technical feature the previously undefined term "*user interface functionality*" refers.

4.2 Claim 13

The claim attempts to define an *apparatus feature* in terms of a *method step*, thereby leading to a lack of clarity. A wording such as "*adapted to*" appears more suitable.

4.3 **Claims 6, 11 and 12** contain erroneous references to other claims:

4.3.1 Although formally dependent on claims 1-5, **claim 6** refers to "the at least one motion sensor" first defined in claim 5.

4.3.2 Analogously, **claim 11** refers to "the second display" first defined in claim 10.

4.3.3 Analogously, **claim 12** refers to "the second display" first defined in claim 10 and referred to in claim 11.

4.4 The "*embodiments*" disclosed on pages 27-33 do not fall within the scope of independent claim 1. This inconsistency between the claims and the description leads to doubt concerning the matter for which protection is sought.

5 Further objections

5.1 **Rule 42(1)(b) EPC**: the relevant prior art disclosed in documents **D2**-**D5** is not mentioned in the description.

5.2 **Rule 43(1) EPC**: the independent claims have not been drafted in the two-part form (see **Guidelines F-IV, 2.2 and 2.3**).

5.3 **Rule 43(7) EPC**: the features of the claims have not been provided with reference signs (see **Guidelines F-IV, 4.19**).

5.4 **Rule 46(2)(i) EPC**: identical reference signs 101/102/103 are inconsistently used for both apparatus features (figs.1-3) and method steps (fig.4).

European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?
Contact Customer Services at www.epo.org/contact

Guardian
IP Consulting I/S
Diplomvej, Building 381
2800 Kgs. Lyngby
DANEMARK

Date
23.03.17

Reference	Application No / Patent No
P1266EP00	11847582.1 - 1568 / 2649409 PCT/DK2011050461
Applicant/Proprietor	
3Shape A/S	

Communication

The extended European search report is enclosed.

The extended European search report includes, pursuant to Rule 62 EPC, the supplementary European search report (Art. 153(7) EPC) and the European search opinion.

Copies of documents cited in the European search report are attached.

☑ 0 additional set(s) of copies of such documents is (are) enclosed as well.

Refund of the search fee
If applicable under Article 9 Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent later.

Should you wish to further prosecute this application in the examination phase, your attention is drawn to the provisions of Rule 70a EPC. An invitation to respond to the extended European search report will be issued shortly (R. 70(2) EPC).

Exhibit 1004 page 1153 of 1621
DENTAL IMAGING

European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?
Contact Customer Services at www.epo.org/contact

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IP Consulting I/S
Diplomvej, Building 381
2800 Kgs. Lyngby
DANEMARK

Date
11.04.17

Reference	Application No / Patent No
P1266EP00	11847582.1 - 1568 / 2649409 PCT/DK2011050461
Applicant/Proprietor	
3Shape A/S	

Communication pursuant to Rules 70(2) and 70a(2) EPC

A supplementary European search report has been drawn up concerning the above-identified European patent application (publication number: 2649409).

Since the request for examination has been filed (R. 70(1), 159(1)(f), Art. 94(1) EPC) prior to the transmission of the supplementary European search report, you are hereby invited to indicate within

six months

of notification of this communication whether you wish to proceed further with the European patent application.

If you do not indicate in due time that you wish to proceed further with the European patent application, it **will be deemed to be withdrawn** (R. 70(3) EPC).

You are invited, within the above-mentioned six-month period, to comment on the objections raised in the opinion accompanying the European search report and/or to file any amendments to the description, claims and drawings correcting any deficiencies noted in the opinion (R. 70a(2), R. 137(2) EPC; Guidelines for Examination in the EPO, B-XI, 8).

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the Examining Division requesting that you correct this deficiency (R. 137(4) EPC).

Should the reply to the invitation pursuant to Rule 70a(2) EPC be filed in an admissible non-EPO language, a translation is to be submitted within one month of its filing (R. 6(2) EPC).

Should you not comply with this invitation within the time limit, the application will be deemed to be **withdrawn** in accordance with Rule 70a(3) EPC.

Receiving Section

Registered letter

Exhibit 1004 page 1154 of 1621
DENTAL IMAGING

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EUROPEAN PATENT OFFICE
D-80298 MUnchen
GERMANY

23 October 2017

Our ref.: P1266EP00

European Patent Application No. 11847582.1
Applicant: 3Shape A/S

Dear Madam/Sir

We refer to communication pursuant to Rules 70(2) and 70a(2) EPC of 11 April 2017 and hereby inform you that the applicant wishes to proceed further with the application according to Rule 70(2) EPC.

Kind regards
Guardian IP Consulting I/S
Association No 373

Lau Lund Olsen
European patent attorney
Phone No.: +45 77 34 44 69

Exhibit 1004 page 1155 of 1621
DENTAL IMAGING

Europäisches Patentamt
European Patent Office
Office européen des brevets

Letter accompanying subsequently filed items

Representative:
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The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number	11847582.1
Applicant's or representative's reference	P1266EP00

	Description of document	Original file name	Assigned file name
1	Letter relating to the search and examination procedure	2017-10-23 - EPO's Proceed further - P1266EP00.pdf	EPLETT-1.pdf

	Payment	
1	Mode of payment	Not specified

Signatures

Place:	Lyngby
Date:	23 October 2017
Signed by:	Lau Olsen 55784
Association:	Guardian IP Consulting I/S
Representative name:	Lau Lund Olsen
Capacity:	(Representative)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Acknowledgement of receipt

We hereby acknowledge receipt of the following subsequently filed document(s):

Submission number	5722891
Application number	EP11847582.1
Date of receipt	23 October 2017
Receiving Office	European Patent Office, The Hague
Your reference	P1286EP00
Applicant	All applicants as on file
Documents submitted	package-data.xml epf1038.pdf (1 p.) ep-afd-request.xml EPLETT-1.pdf\2017-10-23 - EPOfr Proceed further - P1286EP00.pdf (1 p.)
Submitted by	CN=Lau Olsen 55704
Method of submission	Online
Date and time receipt generated	23 October 2017, 10:38 (CEST)
Message Digest	F6:E7:95:6B:CD:C4:6E:AC:37:AC:C7:1D:9F:54:AD:21:5A:DA:81:33

Correction by the EPO of errors in debit instructions filed by eOLF
Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

(European Patent Office)

Exhibit 1004 page 1157 of 1621
DENTAL IMAGING

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
P2635PC00		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/DK2011/050461	05/12/2011	06/12/2010
Applicant 3SHAPE A/S		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 6 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☒ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   ☐ the text is approved as submitted by the applicant.

   ☒ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

   a. the figure of the **drawings** to be published with the abstract is Figure No. 2a

   ☒ as suggested by the applicant.

   ☐ as selected by this Authority, because the applicant failed to suggest a figure.

   ☐ as selected by this Authority, because this figure better characterizes the invention.

   b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK2011/050461

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-34, 38-52

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK2011/050461

Box No. IV Text of the abstract (Continuation of item 5 of the first sheet)

Disclosed is a system comprising a handheld device (100) and at least one display (101), where the handheld device (100) is adapted for performing at least one action in a physical 3D environment. The actions include measuring, modifying, manipulating, recording, touching, sensing, scanning, moving, transforming, cutting, welding, chemically treating, cleaning. The display (101) is adapted for visually representing the physical 3D environment, and where the handheld device (100) is adapted for remotely controlling the view with which the 3D environment is represented on the display (101).

Exhibit 1004 page 1160 of 1621
DENTAL IMAGING

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK2011/050461

A. CLASSIFICATION OF SUBJECT MATTER
G01B 11/24 (2006.01), A61C 13/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC/EC: G06F, G01B, A61C; ICO: K63F; FT:4C061/CC

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
DK, SE, FI, NO (IPC classes as above)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC, WPI, TXTE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X; A	US 2009/0217207 A1 (KAGERMEIER et al) 2009.08.27, entire application, in particular sections [0007], [0009], [0012]-[0013], [0019] -[0020], [0023], [0035]-[0039], fig. 1-4	1-33, 38-48, 50-52; 34, 49
X; A	WO 2004/066615 A1 (NOKIA CORPORATION) 2004.08.05, page 3, line 16 to page 4, line 2, page 25, line 12, to page 26, line 5.	1, 3-14, 16-33, 38-48, 50-52; 2, 15, 34, 49
X; A	US 2003/0158482 A1 (POLAND et al) 2003.08.21, sections [0032], [0034], figs 6, 8.	1-11, 15-17, 26-33, 38-39, 46, 48, 50-52; 12-14, 18-25, 34, 40, 41-45, 47
A	US 2009/0061381 A1 (DURBIN et al) 2009.03.05, sections [0018]-[0019], [0024]	1-33, 38-52

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17/02/2012	22/02/2012
Name and mailing address of the ISA/ Nordic Patent Institute, Helgeshøj Allé 81, DK-2630 Taastrup, Denmark. Facsimile No. +45 43 50 80 08	Authorized officer Lennart Bitsch Telephone No. +45 43 50 8244

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/DK2011/050461

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US2009217207 A1	20090827	CN101513350 A DE102008010717 A1	20090826 20090827
WO2004066615 A1	20040805	US2006146009 A1 EP1588552 A1 AU2003303787 A1	20060706 20051026 20040813
US2003158482 A1	20030821	JP2005517515 A WO03071306 A1 EP1488253 A1 EP1488253 B1 DE60308495T T2 CN1636151 A CN100340867C C AU2003247479 A1 AT340365T T US7141020 B2	20050616 20030828 20041222 20060920 20070606 20050706 20071003 20030909 20061015 20061128
US2009061381 A1	20090305	WO2009033108 A1 KR20100066538 A JP2010538302 A EP2185891 A1 CA2698525 A1	20090312 20100617 20101209 20100519 20090312

Continuation of Box no. III

This International Searching Authority found multible inventions.

US 2009/0217207 A1 (KAGERMEIER et al) 2009.08.27 describes a system comprising a handheld device (10) and at least one display (3, 22), where the handheld device is adapted for switching between
-performing at least one action in a physical 3D environment, where the at least one display is adapted for visually representing the physical 3D environment ([0013], [0037]), and
-remotely controlling the view with which the 3D environment is represented on the display ([0007], [0036], [0039])

The general concept described in the independent claim 1 is known from US 2009/0217207, and the application does therefore describe 4 inventions

A: Claims 2-34, 38-52 describe modifications of a system, a method, and a computer program product comprising a handheld device for performing at least one action, and for remotely controlling the view, and wherein the handheld device is an intra-oral 3D scanner
B: Claim 35 describes a system wherein the handheld device of claim 1 is a surgical instrument
C: Claim 36 describes a system wherein the handheld device of claim 1 is a mechanical tool
D: Claim 37 describes a system wherein the handheld device of claim 1 is an in-ear 3D scanner

There is no Single General Inventive Concept among the inventions A, B, C and D, and there is, therefore, not a technical relationship to link the invention as defined in Rules 13.1 and 13.2 PCT.

Electronic Acknowledgement Receipt

EFS ID:	45535412
Application Number:	17533403
International Application Number:	
Confirmation Number:	9694
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Customer Number:	21839
Filer:	William C. Rowland/Stacey Pflieger
Filer Authorized By:	William C. Rowland
Attorney Docket Number:	0079124-000370-T1
Receipt Date:	22-APR-2022
Filing Date:	23-NOV-2021
Time Stamp:	15:47:26
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	FOLEY_Introduction_to_Computer.pdf	13427543 d25885915c637bd4b636ee1d3668ef3b38d5eebc	no	66

Warnings:

Information:					
2	Non Patent Literature	HALE_Measuring_Free.pdf	857736 81d58ee2b35934f3aa2d6be166c3a79e6fa4ff7d	no	7
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6	Non Patent Literature	MYERS_Graphical_User.pdf	3036223 95963b73a28a74515945ea8853eb2047285a471b	no	30
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9	Non Patent Literature	Plaintiff_and_Counterclaim.pdf	169380 b5eedc6fc3873d09bfd6f6fb738bf68bbb3852ad	no	4
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12	Non Patent Literature	WELCH_High_Performance.pdf	2191442 b2ebdf17a890cba8a3719289f8e6db8e6236d5cf	no	22
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14	Foreign Reference	CN_101513350_A.pdf	1643322 d5067afa51440b41b48ce037a86c874330e86e74	no	17
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39	Non Patent Literature	9329675_Decision_Denying_Petitioners_IPR2019800198.pdf	417693 862a282356682c375002a5212e849f6478105896	no	8
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58	Non Patent Literature	9329675_Patent_Owners_Preliminary_Response_IPR201800197.pdf	3206690 6c50d6af7e5378f0e756b7bfe066c841debefad6	no	66
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59	Non Patent Literature	9329675_Patent_Owners_Preliminary_Response_IPR201800198.pdf	3224130 d4d358f86056ee061fa7e33c97323a754a27da24	no	66
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Information:					
		Total Files Size (in bytes):	203255682		

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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune Fisker
Art Unit	2484
Examiner Name	Jose M Mesa
Attorney Docket Number	0079124-000370-T1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17533403
	Filing Date	2021-11-23
	First Named Inventor	Rune Fisker
	Art Unit	2484
	Examiner Name	Jose M Mesa
	Attorney Docket Number	0079124-000370-T1

	1	WELCH et al., "High-Performance Wide-Area Optical Tracking The HiBall Tracking System", Presence: Teleoperators and Virtual Environments, Vol. 10, No. 1, February 2001, pp. 1-22.	☐
	2	WELCH et al., "Motion Tracking: No Silver Bullet, but a Respectable Arsenal", IEEE Computer Graphics and Applications, Vol. 22, No. 6, December 10, 2002, pp. 24-38.	☐
	3	WILSON et al., "Confocal Microscopy by Aperture Correlation", Optics Letters Vol. 21, Issue 23, 1996, pp. 1879-1881 (4 pages).	☐
	4	WILSON et al., "Real-Time Three-Dimensional Imaging of Macroscopic Structures", Journal of Microscopy, Vol. 191, No. 2, August 1998, pp. 116-118.	☐
	5	XIA et al., "Three-Dimensional Virtual-Reality Surgical Planning and Soft-Tissue Prediction for Orthognathic Surgery", IEEE Transactions on Information Technology in Biomedicine, Vol.5, No.2, June 2001, pp. 97-107.	☐
	6	YOSHIDA et al., "Intraoral Ultrasonic Scanning as a Diagnostic Aid", Journal of Cranio-Maxillofacial Surgery, Vol. 15, 1987, pp. 306-311.	☐
	7	ZHANG et al., "A 3-dimensional Vision System for Dental Applications", Proceedings of the 29th Annual International, August 23-26, 2007, pp. 3369-3372.	☐
	8	BOWMAN et al., "3D User Interfaces Theory and Practice § 4.1.1 "Input Device Characteristics" pp 88- 89; § 4.2.2 "2D Mice and Trackballs" pp 91-92; § 4.8.2 "Input Device Taxonomies" pp 128-132", (IPR2018-00197, Ex. 2013), 2005, 20 pages.	☐
	9	SCHENDEL et al., "3D Orthognathic Surgery Simulation Using Image Fusion", Seminars in Orthodontics, Vol 15, No 1, March 2009, pp. 48-56 (11 pages).	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17533403
	Filing Date	2021-11-23
	First Named Inventor	Rune Fisker
	Art Unit	2484
	Examiner Name	Jose M Mesa
	Attorney Docket Number	0079124-000370-T1

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune Fisker
Art Unit	2484
Examiner Name	Jose M Mesa
Attorney Docket Number	0079124-000370-T1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☑ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/WCRowland/	Date (YYYY-MM-DD)	2022-04-22
Name/Print	William C. Rowland	Registration Number	30,888

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Exhibit 1004 page 1178 of 1621
DENTAL IMAGING

Electronic Patent Application Fee Transmittal

Application Number:	17533403
Filing Date:	23-Nov-2021
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Filer:	William C. Rowland/Stacey Pflieger
Attorney Docket Number:	0079124-000370-T1

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
PETITION FEE- 37 CFR 1.17(H) (GROUP III)	1464	1	140	140
RCE- 1ST REQUEST	1801	1	1360	1360
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1500**

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Decision Date : April 22, 2022

In re Application of :

Rune FISKER

DECISION ON PETITION
UNDER CFR 1.313(c)(2)

Application No : 17533403

Filed : 23-Nov-2021

Attorney Docket No : 0079124-000370-T1

This is an electronic decision on the petition under 37 CFR 1.313(c)(2), filed April 22, 2022 , to withdraw the above-identified application from issue after payment of the issue fee.

The petition is **GRANTED.**

The above-identified application is withdrawn from issue for consideration of a submission under 37 CFR 1.114 (request for continued examination). See 37 CFR 1.313(c)(2).

Petitioner is advised that the issue fee paid in this application cannot be refunded. If, however, this application is again allowed, petitioner may request that it be applied towards the issue fee required by the new Notice of Allowance.

Telephone inquiries concerning this decision should be directed to the Patent Electronic Business Center (EBC) at 866-217-9197.

This application file is being referred to Technology Center AU 2484 for processing of the request for continuing examination under 37 CFR 1.114 .

Office of Petitions

Electronic Acknowledgement Receipt

EFS ID:	45541124
Application Number:	17533403
International Application Number:	
Confirmation Number:	9694
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Customer Number:	21839
Filer:	William C. Rowland/Stacey Pflieger
Filer Authorized By:	William C. Rowland
Attorney Docket Number:	0079124-000370-T1
Receipt Date:	22-APR-2022
Filing Date:	23-NOV-2021
Time Stamp:	15:46:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1500
RAM confirmation Number	E20224LF46312426
Deposit Account	024800
Authorized User	Stacey Pflieger

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	ePetition Request Form	petition-request.pdf	39722 bd371a0aeb22f6ca8a1cddf0b1b66030c83fab3a	no	2
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	370rce.pdf	223553 ede7489b5d6a4cd2eaeca761bc7c01586bfc27f6	no	3
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	370ids.pdf	119989 612465a92b131a5d88a4aa51aa536ea50e15dc75	no	17
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
4	Information Disclosure Statement (IDS) Form (SB08)	370-ids2.pdf	80640 f8f2cf2cac3258672f358b222eacd006294c5a82	no	5
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
5	Fee Worksheet (SB06)	fee-info.pdf	40234 973a2952e08ec885908c91b9dc11347c2bd33e1d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	504138		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: PET.AUTO Document Description: Petition automatically granted by EFS-Web	PTO/SB/140 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**PETITION TO WITHDRAW AN APPLICATION FROM ISSUE AFTER PAYMENT OF THE ISSUE FEE UNDER 37 CFR 1.313(c)**
Application Number	17533403
Filing Date	23-Nov-2021
First Named Inventor	Rune FISKER
Art Unit	2484
Examiner Name	
Attorney Docket Number	0079124-000370-T1
Title	FOCUS SCANNING APPARATUS

An application may be withdrawn from issue for further action upon petition by the applicant. To request that the Office withdraw an application from issue, applicant must file a petition under this section including the fee set forth in § 1.17(h) and a showing of good and sufficient reasons why withdrawal of the application from issue is necessary.

APPLICANT HEREBY PETITIONS TO WITHDRAW THIS APPLICATION FROM ISSUE UNDER 37 CFR 1.313(c).

A grantable petition requires the following items:
(1) Petition fee; and
(2) One of the following reasons:
(a) Unpatentability of one or more claims, which must be accompanied by an unequivocal statement that one or more claims are unpatentable, an amendment to such claim or claims, and an explanation as to how the amendment causes such claim or claims to be patentable;
(b) Consideration of a request for continued examination in compliance with § 1.114 (for a utility or plant application only); or
(c) Express abandonment of the application. Such express abandonment may be in favor of a continuing application, but not a CPA under 37 CFR 1.53(d).

Petition Fee

- ◯ Small Entity
- ◯ Micro Entity
- ◉ Regular Undiscounted

Reason for withdrawal from issue

○ One or more claims are unpatentable ◉ Consideration of a request for continued examination (RCE) (List of Required Documents and Fees) ○ Applicant hereby expressly abandons the instant application (any attorney/agent signing for this reason must have power of attorney pursuant to 37 CFR 1.32(b)).	
RCE request,submission, and fee. ☐ I certify, in accordance with 37 CFR 1.4(d)(4) that : The RCE request ,submission, and fee have already been filed in the above-identified application on ☒ Are attached.	
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: ◉ An attorney or agent registered to practice before the Patent and Trademark Office who has been given power of attorney in this application. ○ An attorney or agent registered to practice before the Patent and Trademark Office, acting in a representative capacity. ○ A sole inventor ○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ○ A joint inventor; all of whom are signing this e-petition	
Signature	/WCRowland/
Name	William C. Rowland
Registration Number	30888

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune Fisker
Art Unit	2484
Examiner Name	Jose M Mesa
Attorney Docket Number	0079124-000370-T1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	2	5737084	A	1998-04-07	Ishihara, Mitsuhiro	
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	5	6135961	A	2000-10-24	Pflugrath et al.	
	6	6251073	B1	2001-06-26	Imran et al.	
	7	6361489	B1	2002-03-26	Tsai, Jory	
	8	6532299	B1	2003-03-11	Sachdeva et al.	

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	Attorney Docket Number	0079124-000370-T1

	9	6751344	B1	2004-06-15	Grumbine, Michael T.	
	10	6761561	B2	2004-07-13	Mandelkern et al.	
	11	6967644	B1	2005-11-22	Kobayashi, Kiwamu	
	12	6975898	B2	2005-12-13	Seibel, Eric J.	
	13	6977732	B2	2005-12-20	Chen et al.	
	14	7058213	B2	2006-06-06	Rubbert et al.	
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If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	2	20030158482	A1	2003-08-21	Poland et al.	
	3	20040204787	A1	2004-10-14	Kopelman et al.	
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If you wish to add additional U.S. Published Application citation information please click the Add button.

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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	5	9714932	WO	A1	1997-04-24	Optronic Consult Ab		☐
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	8	2004066615	WO	A1	2004-08-05	Nokia Corporation		☐
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	14	2010106379	WO	A1	2010-09-23	Mediwatch Uk Limited		☐
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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	3Shape A/S v. Align Technology, Inc., IPR2021-01383, Petition for Inter Partes Review, U.S. Patent No. 10,728,519, August 20, 2021, 112 pages.	☐
	2	Decision Denying Petitioner's Request for Rehearing in IPR20198-00198, U.S. Patent No. 9,329,675, December 4, 2018, 8 pages.	☐
	3	Declaration of Dr. Chandrajit Bajaj ("Bajaj Decl.") in support of Petition for Inter Partes Review, U.S. Patent No. RE48,221, 377 pages.	☐
	4	VOGT et al., "An AR System With Intuitive User Interface For Manipulation and Visualization of 3D Medical Data", Studies in Health Technology and Informatics, Vol. 98, 2004., pp 397-403.	☐

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	5	Declaration of Dr. Chandrajit L. Bajaj, (IPR2018-00197, Ex. 1003), July 25, 2018, 142 pages.	☐
	6	Declaration of Ravin Balakrishanan, (IPR2018-00197, EX.2011), 55 pages.	☐
	7	Deposition Transcript of Chandrajit Bajaj, Ph.D with Errata Sheet, (IPR2018-00197 Ex-2008), July 25, 2018, 142 pages.	☐
	8	Deposition Transcript of Dr. Ravin Balakrishnan, November 5, 2018, 101 pages.	☐
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	10	File History (IPR2018-00197, Ex. 1002) (IPR2018-00198, Ex. 1002), U.S. Patent No. 9,329,675, 625 pages.	☐
	11	Final Written Decision - Termination Decision Document from IPR2018-00197, U. S. Patent No. 9,329,675 B2, May 29, 2019, 64 pages.	☐
	12	Institution Decision entered in IPR20198-00197, U.S. Patent No. 9,329,675, May 30, 2018, 32 pages.	☐
	13	Introducing Wii MotionPlus, Nintendo's upcoming accessory for the revolutionary Wii Remote, Nintendo, The Wayback Machine, July 14, 2008, 2 pages.	☐
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	16	Patent Owner's Response to the Petition for Inter Partes Review in IPR2018-00197, U.S. Patent No. 9,329,675, August 20,2018, 57 pages.	☐
	17	Patent Owner's Submission of Demonstratives for Oral Argument in IPR2018- 00197, U.S. Patent No. 9,329,675, January 31, 2019, 42 pages.	☐
	18	Petition for Inter Partes Review, U.S. Patent No. 9,329,675, November 22, 2017, 67 pages.	☐
	19	Petitioner Align Technology, Inc.'s Demonstratives in IPR2018-00197, U.S. Patent No. 9,329,675, January 31, 2019, 30 pages.	☐
	20	Petitioner Align Technology, Inc.'s Reply to Patent Owner Response in IPR2018-00197, U.S. Patent No. 9,329,675, November 14, 2018, 35 pages.	☐
	21	Petitioner's Align Technology, Inc's Request For Rehearing in IPR20198-00198, U.S. Patent No. 9,329,675, June 29, 2018, 14 pages.	☐
	22	Plaintiff and Counterclaim Defendant Align Technology, Inc.'s Stipulation Regarding IPR2022-00144 and IPR2022-00145, Case No. 6:20-cv-00979 (W.D. Tex.), December 16, 2021, 4 pages.	☐
	23	Record of Oral Hearing in IPR2018-00197, U.S. Patent No. 9,329,675, February 4, 2019, 67 pages.	☐
	24	Taxonomies of Input in Developing a Taxonomy of Input, (IPR2018-00197, Ex. 2010) Available at https:/iwww.billbuxton.com/input04.Taxonomies.pdf., January 04, 2009, 16 pages.	☐
	25	U.S. Patent Application Serial No. 10/744,869, (IPR2018-00197, Ex. 2005), 69 pages.	☐
	26	AHN et al., "Development of Three-Dimensional Dental Scanning Apparatus Using Structured Illumination", Sensors, Vol. 17, Issue 7, 1634 (IPR2018-00197, Ex. 2004) (IPR2018-00198, Ex. 2002), 2017, 9 pages.	☐

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	27	BOWMAN et al., "3D User Interfaces: Theory and Practice", 2004, pp. 96-101, (IPR2018-00197, Ex. 1038) July 2004, pp. 96-101 (9 pages).	☐
	28	CHUA et al., "SonoDEX: 3D Space Management and Visualization of Ultrasound Data", International Congress Series, Vol. 1281, (I PR2018-00197, Ex. 2006), May 2005, pp.143-148.	☐
	29	First Office Action dated April 3, 2015, issued in the corresponding Chinese Patent Application No. 201180066956.6, 13 pages.	☐
	30	Second Office Action dated November 18, 2015, issued in the corresponding Chinese Patent Application No. 201180066956.6, 27 pages.	☐
	31	EPO Prosecution History dated June,19,2013, issued in the European Patent Application No. 11847582.1, 180 pages.	☐
	32	FOLEY et al., "Introduction to Computer Graphics", Addison-Wesley, Chapter 2.2: Basic Interaction Handling," "Chapter 6: Viewing in 3D," and "Chapter 8: Input Devices, Interaction Techniques, and Interaction Tasks, 1994, 66 pages.	☐
	33	GAO et al., "3D Shape Reconstruction of Teeth by Shadow Speckle Correlation Method", Optics and Lasers in Engineering, Vol. 44, 2006, pp. 455-465.	☐
	34	GMITRO et al., "Confocal Microscopy through a Fiber-Optic Imaging Bundle", Optics Letters, Vol. 18, No. 8, April 15, 1993, pp. 565-567 (4 pages).	☐
	35	GRAETZEL et al., "A Non-Contact Mouse for Surgeon-Computer Interaction", Technology and Health Care, Vol. 12, No. 3, 2004, pp. 245-257.	☐
	36	HALE et al., "Measuring Free-Living Physical Activity in Adults with and Without Neurologic Dysfunction with a Triaxial Accelerometer", Archives of Physical Medicine and Rehabilitation, Vol. 89, No. 9, September 2008, pp. 1765-1771.	☐
	37	HEARN et al., "Computer Graphics", 2d. Ed., Prentice Hall, Chapter 2: Overview of Graphics Systems, "Chapter 8: Graphical User Interfaces and Interactive Input Methods," and "Chapter 9: Three-Dimensional Concepts", 1994, 83 pages.	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17533403
	Filing Date	2021-11-23
	First Named Inventor	Rune Fisker
	Art Unit	2484
	Examiner Name	Jose M Mesa
	Attorney Docket Number	0079124-000370-T1

	38	JERALD JASON, "The VR Book: Human-Centered Design for Virtual Reality", (IPR2018-00197 Ex-2014), 2016, 4 pages.	☐
	39	KAUFMANN HANNES, "Applications of Mixed Reality", Thesis, Vienna University of Technology, May 27, 2009, 95 pages.	☐
	40	MACKINLAY et al., "A Semantic Analysis of the Design Space of Input Devices", Human Computer Interaction, Vol. 5, 1990, pp. 145-190.	☐
	41	MORAN et al., "A Comparison of the Imaging Performance of High Resolution Ultrasound Scanners for Preclinical Imaging", Ultrasound in Medicine & Biology, Vol. 37, No. 3, March 2011, pp. 493-501.	☐
	42	MYERS BRADA. , "Graphical User Interface Programming", CRC Handbook of Computer Science and Engineering, 2d. Ed., Allen B. Tucker, January 27, 2003, 30 pages.	☐
	43	NASIRI STEVEN, "A Critical Review of MEMS Gyroscopes Technology and Commercialization Status", InvenSense, 2005, 8 pages.	☐
	44	ÖJELUND et al., "Inter Partes Review Certificate", U.S. Patent No. 9,329,675 K1, 2 pages.	☐
	45	International Search Report (PCT/ISA/210) dated February 22, 2012, issued in the International Patent Application No. PCT/DK2011/050461, 6 pages.	☐
	46	SINESCU et al., "Laser Beam Used in Dental Scanning for CAD/CAM Technologies", TMJ, Vol. 57, No. 2-3, 2007, pp. 187-191 (6 pages).	☐
	47	STEELE et al., "Bodies in Motion: Monitoring Daily Activity and Exercise with Motion Sensors in People with Chronic Pulmonary Disease", Journal of Rehabilitation Research & Development, Vol. 40, No. 5, Suppl. 2, October 2003, pp. 45-58.	☐
	48	TIZIANI et al., "Theoretical Analysis of Confocal Microscopy with Microlenses", Applied Optics Vol. 35, Issue 1, January 01, 1996, pp. 120-125 (7 pages).	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17533403
	Filing Date	2021-11-23
	First Named Inventor	Rune Fisker
	Art Unit	2484
	Examiner Name	Jose M Mesa
	Attorney Docket Number	0079124-000370-T1

	49	TURNER DANIEL, "Hack: The Nintendo Wii", MIT Technology Review, July 1, 2007, 3 pages.	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune Fisker
Art Unit	2484
Examiner Name	Jose M Mesa
Attorney Docket Number	0079124-000370-T1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☑ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/WCRowland/	Date (YYYY-MM-DD)	2022-04-22
Name/Print	William C. Rowland	Registration Number	30,888

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/SB/30 (11-17)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	17/533,403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER
Art Unit	2484
Examiner Name	JOSE MESA
Attorney Docket Number	0079124-000370-T1

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

      i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

      ii. ☐ Other _____

   b. ☑ Enclosed

      i. ☐ Amendment/Reply

      ii. ☐ Affidavit(s)/ Declaration(s)

      iii. ☑ Information Disclosure Statement (IDS)

      iv. ☑ Other Petition to Withdraw from Issue

2. Miscellaneous

   a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. ☐ Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. ☑ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 02-4800.

      i. ☐ RCE fee required under 37 CFR 1.17(e)

      ii. ☐ Extension of time fee (37 CFR 1.136 and 1.17)

      iii. ☐ Other _____

   b. ☐ Check in the amount of $ _____ enclosed

   c. ☐ Payment by credit card (Form PTO-2038 enclosed)

   d. ☑ Payment by EFS-Web

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/WCRowland/	Date	April 22, 2022
Name (Print/Type)	William C. Rowland	Registration No.	30,888

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being EFS-Web transmitted to the United States Patent and Trademark Office (USPTO), deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the USPTO on the date shown below.

Signature			
Name (Print/Type)	-- SELECT --	Date	

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Instruction Sheet for RCEs

(not to be submitted to the USPTO)

NOTES:

An RCE is not a new application, and filing an RCE will not result in an application being accorded a new filing date.

Filing Qualifications:

The application must be a utility or plant application filed on or after June 8, 1995. The application cannot be a provisional application, a utility or plant application filed before June 8, 1995, a design application, or a patent under reexamination. See 37 CFR 1.114(e).

Filing Requirements:

Prosecution in the application must be closed. Prosecution is closed if the application is under appeal, or the last Office action is a final action, a notice of allowance, or an action that otherwise closes prosecution in the application (e.g., an Office action under *Ex parte Quayle*). See 37 CFR 1.114(b).

A submission and a fee are required at the time the RCE is filed. If reply to an Office action under 35 U.S.C. 132 is outstanding (e.g., the application is under final rejection), the submission must meet the reply requirements of 37 CFR 1.111. If there is no outstanding Office action, the submission can be an information disclosure statement, an amendment, new arguments, or new evidence. See 37 CFR 1.114(c). The submission may be a previously filed amendment (e.g., an amendment after final rejection).

WARNINGS:

Request for Suspension of Action:

All RCE filing requirements must be met before suspension of action is granted. A request for a suspension of action under 37 CFR 1.103(c) does not satisfy the submission requirement and does not permit the filing of the required submission to be suspended.

Improper RCE will NOT toll Any Time Period:

Before Appeal - If the RCE is improper (e.g., prosecution in the application is not closed or the submission or fee has not been filed) and the application is not under appeal, the time period set forth in the last Office action will continue to run and the application will be abandoned after the statutory time period has expired if a reply to the Office action is not timely filed. No additional time will be given to correct the improper RCE.

Under Appeal - If the RCE is improper (e.g., the submission or the fee has not been filed) and the application is under appeal, the improper RCE is effective to withdraw the appeal. Withdrawal of the appeal results in the allowance or abandonment of the application depending on the status of the claims. If there are no allowed claims, the application is abandoned. If there is at least one allowed claim, the application will be passed to issue on the allowed claim(s). See MPEP 1215.01.

See MPEP 706.07(h) for further information on the RCE practice.

Exhibit 1004 page 1205 of 1621
DENTAL IMAGING

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/533,403	11/23/2021	Rune FISKER	0079124-000370-T1	9694

21839 7590 04/11/2022

BUCHANAN, INGERSOLL & ROONEY PC
1737 KING STREET
SUITE 500
ALEXANDRIA, VA 22314-2727

EXAMINER	
MESA, JOSE M	

ART UNIT	PAPER NUMBER
2484	

NOTIFICATION DATE	DELIVERY MODE
04/11/2022	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ADIPDOC1@BIPC.com

Corrected ***Notice of Allowability***	**Application No.** 17/533,403	**Applicant(s)** FISKER et al.	
	Examiner JOSE M MESA	**Art Unit** 2484	**AIA (FITF) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 11/23/2021.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 2-20 and 22-33 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 11/23/2021 01/05/2022 02/02/2022.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/JOSE M MESA/ Examiner, Art Unit 2484	/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Terminal Disclaimer

The terminal disclaimers filed on 02/02/2022 and 02/22/2022 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of U.S. Patent No. 11,076,146 and U.S. Patent No. 10,595,010 have been reviewed and are accepted. The terminal disclaimers have been recorded.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with William C. Rowland on 03/11/2022. In the examiner's amendment claim 22 is amended to correct a typographical error, wherein claim 22 now depends on claim 15 as shown below.

22. (Currently Amended) The handheld intraoral scanner according to claim 15, wherein the hardware processor is further configured to selectively switch the color of the probe light by switching on and off the at least three monochromatic light sources.

Allowable Subject Matter

1. Claims 2-20 and 22-33 are allowed.

The following is an examiner's statement of reasons for allowance: **Independent claim 2** recites the uniquely distinct features for: "...a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern; an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;..." **And independent claim 15** recites the uniquely distinct features for: "...a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern; an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern,..." **And independent claim 28** recites the uniquely distinct features for: "...a pattern generator configured to generate, using a light source,

a probe light with a plurality of configurations in the form of a time-varying illumination pattern; an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;..." The closest prior art in Babayoff et al. (US 2005/0283065) teaches a device 100 comprises a main illumination source 31 for illuminating the object of interest 26, typically a part of the intraoral cavity, and is optically coupled to main optics 41 to provide depth Z values for an array range of X-Y points (according to a known frame of reference) along the surface of the object 26. Detection optics 60 comprises an image sensor, typically a CCD, that is preferably monochromatic to maximise the resolution of the device, and which typically defines the X-Y frame of reference. Alternatively, the CCD may be adapted to receive color images. The detection optics 60 receives image data from the main optics 41 and the image processor 24 determines the depth Z values for each X-Y point illuminated on the object 26 based on this image data, Heinz et al. (US 2007/0041729) teaches an illustrative illumination arrangement 800 using a multimode optical fiber 802 to monitor a surface 804 with a detector 805 (e.g., detector 104 of FIG. 1, detector 302 of FIG. 3A, or detector A of FIG. 7, 7A). Optical radiation 806 that reflects from surface 804 will exhibit time-varying changes if surface 804 vibrates, if fiber 802 moves across surface 804, or if distance d changes (e.g., through tilt or movement of surface 804). The multimode interference pattern that illuminates detector 805 is time-varying in accordance with the movement of surface 804 (or end 814 or d), however, either singular or in combination, fails to anticipate or render the above underlined limitations obvious.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSE M MESA whose telephone number is (571)270-1706. The examiner can normally be reached on Monday-Friday 8:30AM-6:00PM ET.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thai Tran can be reached on 571-272-7382. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

2/2/2022

/JOSE M MESA/
Examiner, Art Unit 2484

/THAI Q TRAN/
Supervisory Patent Examiner, Art Unit 2484

Notice of References Cited	Application/Control No. 17/533,403	Applicant(s)/Patent Under Reexamination FISKER et al.	
	Examiner JOSE M MESA	Art Unit 2484	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20050283065-A1	12-2005	Babayoff, Noam	G01J3/508	600/407
*	B	US-20070041729-A1	02-2007	Heinz; Philip	H01L31/02024	398/25
	C					
	D					
	E					
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	K					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	Art Unit
	JOSE M MESA	2484

CPC - Searched*		
Symbol	Date	Examiner
H04N13/296, A61B5/0068, A61B5/1077, G01B11/2513, G01B11/2518, A61B5/1075, A61B5/1076, A61B5/4547, G01B2210/58	02/02/2022	JM

CPC Combination Sets - Searched*		
Symbol	Date	Examiner
H04N13/296, A61B5/0068, A61B5/1077, G01B11/2513, G01B11/2518, A61B5/1075, A61B5/1076, A61B5/4547, G01B2210/58	02/02/2022	JM

US Classification - Searched*			
Class	Subclass	Date	Examiner
348		02/02/2022	JM

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
PE2E Search History, US-PGPUB, USPAT, USOCR, FIT, EPO, JPO, DERWENT, IBM_TDB.	02/02/2022	JM
Searched inventor's name in PALM and PE2E for double patenting.	02/02/2022	JM

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	See PE2E Search History for interference search.	02/02/2022	JM

/JOSE M MESA/ Examiner, Art Unit 2484	/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484

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DENTAL IMAGING

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	**Art Unit**
	JOSE M MESA	2484

CPC						
Symbol					**Type**	**Version**
H04N	/	13	/	296	F	2018-05-01
A61B	/	5	/	0068	I	2013-01-01
G01B	/	11	/	2513	I	2013-01-01
G01B	/	11	/	2518	I	2013-01-01
A61B	/	5	/	1077	I	2013-01-01
A61B	/	5	/	4547	A	2013-01-01
G01B	/	2210	/	58	A	2013-01-01
A61B	/	5	/	1075	A	2013-01-01
A61B	/	5	/	1076	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

/JOSE M MESA/ Examiner, Art Unit 2484 (Assistant Examiner)	31 March 2022 (Date)	**Total Claims Allowed:** 31	
/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484 (Primary Examiner)	06 April 2022 (Date)	O.G. Print Claim(s) 2	O.G. Print Figure 8

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	**Art Unit**
	JOSE M MESA	2484

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04N	/	13	/	296

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

/JOSE M MESA/ Examiner, Art Unit 2484 (Assistant Examiner)	31 March 2022 (Date)	**Total Claims Allowed:** 31	
/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484 (Primary Examiner)	06 April 2022 (Date)	O.G. Print Claim(s) 2	O.G. Print Figure 8

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	**Art Unit**
	JOSE M MESA	2484

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
-	1	9	10	18	19	26	28								
1	2	10	11	19	20	27	29								
2	3	11	12	-	21	28	30								
3	4	12	13	20	22	29	31								
4	5	13	14	21	23	30	32								
5	6	14	15	22	24	31	33								
6	7	15	16	23	25										
7	8	16	17	24	26										
8	9	17	18	25	27										

/JOSE M MESA/ Examiner, Art Unit 2484 (Assistant Examiner)	31 March 2022 (Date)	**Total Claims Allowed:** 31	
/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484 (Primary Examiner)	06 April 2022 (Date)	O.G. Print Claim(s) 2	O.G. Print Figure 8

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	Art Unit
	JOSE M MESA	2484

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/02/2022								
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	31	=								
	32	=								
	33	=								

Bibliographic Data

Application No: 17/533,403

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /JOSE M MESA/ (Examiner's Signature) [ ] (Initials)

Title: FOCUS SCANNING APPARATUS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/23/2021	348	2484	0079124-000370-T1
RULE			

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CONTINUING DATA

This application is a CON of 17340806 06/07/2021

17340806 is a CON of 17206581 03/19/2021 PAT 11076146

17206581 is a CON of 16774843 01/28/2020 PAT 11051002

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PCT/DK2010/050148 has PRO of 61187744 06/17/2009

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

12/06/2021

STATE OR COUNTRY

DENMARK

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UNITED STATES

FILING FEE RECEIVED

$7,160

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	1	(scan$4 scanner) near2 (color near2 probe near2 light)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:52 AM
L2	379	(scan$4 scanner) near50 (color near20 probe near20 light)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:52 AM
L3	47	L2 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:55 AM
L4	1484	(scan$4 scanner) SAME ((switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME probe SAME light SAME object)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 11:56 AM

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DENTAL IMAGING

			IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)				
L5	112	L4 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:57 AM
L6	1312	(scan$4 scanner) SAME ((switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME (images frames pictures) SAME probe SAME light SAME object)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:58 AM
L7	74	L6 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:58 AM
L8	1008	((scan$4 scanner) SAME color SAME (images frames pictures) SAME probe	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/02/02 11:59 AM

		SAME light SAME surface SAME object)	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L9	94	L8 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:59 AM
L10	2645	((switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME (images frames pictures) SAME probe SAME light SAME object)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:00 PM
L11	118	L10 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:01 PM
L12	4446	((switch$4 chang$4	(US-PGPUB; USPAT;	OR	ON	ON	2022/02/02

		modif$4 alter$4 adjust$4) SAME color SAME probe SAME light SAME object)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				12:02 PM
L13	288	L12 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:02 PM
L14	2688	(selectiv$4 SAME (switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME probe SAME light)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:09 PM
L15	44	L14 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/02/02 12:10 PM

			WO); EPO; JPO; DERWENT; IBM_TDB)				
L17	2170	((selectiv$4 select$4) SAME (switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME probe SAME light SAME (object tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:14 PM
L18	59	L17 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:14 PM
L19	84974	((selectiv$4 select$4) SAME (switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME light SAME (object tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:15 PM
L20	994712	("20030096210"|"20040080754"|"20050283065"|"20060158665"|"20070109559"|"20070194214"|"20070252074"|"20090103103"|"20090167948"|"20090279103"|"20100079581"|"20100157086"|"4291958"|"4349880"|"4516231"|"457580	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/02/02 12:21 PM

		5"|"4629324"|"4640620"|"4896015"|"5372502"|"5381236"|"5615003"|"6697164")".PN"	PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L21	2352	L19 AND L20	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:21 PM
L22	330	L19 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:21 PM
L23	741	L20 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:22 PM
L24	20	L21 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 12:22 PM

		A61B5/4547 G01B2210/58).CPC.	IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L25	320	(tim$4 near2 var$4 near2 illuminat$4 near2 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:24 PM
L26	9	L20 AND L25	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:25 PM
L27	239	L25 AND (scan$4 scanner)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:26 PM
L28	49	L25 AND (tooth teeth)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/02/02 12:27 PM

			CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L29	4046	(tim$4 near50 var$4 near50 illuminat$4 near50 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:28 PM
L30	258	L29 AND (tooth teeth)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:28 PM
L31	90	(segment$4 near50 ((led) light near2 emitting near2 diode) near50 scanner)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:34 PM
L32	95	(segment$4 near50	(US-PGPUB; USPAT;	OR	ON	ON	2022/02/02

		((led) light near2 emitting near2 diode) near50 probe near50 light)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				12:36 PM
L33	92	(segmented SAME ((led) light near2 emitting near2 diode) SAME probe SAME light)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:49 PM
L34	102	(optical near2 system near2 substantially near2 achromatic)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:50 PM
L35	67	(optical near50 system near50 substantially near50 achromatic near50 color)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/02/02 12:51 PM

			WO); EPO; JPO; DERWENT; IBM_TDB)				
L36	15	(optical SAME system SAME substantially SAME achromatic SAME (tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:53 PM
L37	144	(tim$4 near50 var$4 near50 illuminat$4 near50 line near50 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:54 PM
L38	492	(tim$4 near50 (var$4 chang$4) near50 illuminat$4 near50 line near50 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:55 PM
L39	20	L38 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/02/02 12:55 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L40	639	(tim$4 SAME (var$4 chang$4) SAME illuminat$4 SAME line SAME pattern SAME (tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:56 PM
L41	18	L40 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:56 PM
L42	894	(tim$4 same5 (var$4 chang$4) same5 illuminat$4 same5 (line adj5 pattern) same5 (tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:58 PM
L43	182	L42 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 12:58 PM

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DENTAL IMAGING

		A61B5/4547 G01B2210/58).CPC.	IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L44	857	(camera near2 two near2 cameras) near50 (tooth teeth)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:11 PM
L45	48	L44 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:12 PM
L46	109	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:14 PM
L47	219	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/02/02 01:15 PM

		WITH pattern WITH (teeth tooth))	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L48	17	L47 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:15 PM
L49	1091	(tim$4 SAME (var$4 chang$4 modif$4 alter$4) SAME (illuminat$4 light$4) SAME pattern SAME (teeth tooth) SAME dimensions)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:16 PM
L50	20	L49 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:16 PM
L51	292	(tim$4 WITH (var$4	(US-PGPUB; USPAT;	OR	ON	ON	2022/02/02

		chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth object) WITH dimensions)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				01:16 PM
L52	8	L51 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:17 PM
L53	292	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth object) WITH dimensions)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:19 PM
L54	8	L53 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/02/02 01:19 PM

			WO); EPO; JPO; DERWENT; IBM_TDB)				
L55	1091	(tim$4 SAME (var$4 chang$4 modif$4 alter$4) SAME (illuminat$4 light$4) SAME pattern SAME (teeth tooth) SAME dimensions)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:19 PM
L56	20	L55 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:20 PM
L57	109	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:20 PM
L58	219	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/02/02 01:20 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L59	17	L58 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:21 PM
L60	435	(fisker-rune).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:21 PM
L61	91	(ojelund-henrik).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:22 PM
L62	25	(kjaer-rasmus).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 01:22 PM

			IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L63	108	(van-der-poel-mike).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:23 PM
L64	33	(qazi-arish-a).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:23 PM
L65	151	(hollenbeck-karl-josef).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:23 PM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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Approved for use through 11/30/2020. OMB 0651-0031
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(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER
Art Unit	
Examiner Name	
Attorney Docket Number	0079124-000370-T1

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	3	11076146	B1	2021-07-27	FISKER, ET AL.	

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	1	COMPLAINT, 3Shape A/S v. Carestream Dental, LLC, Civil Action No. 6:21-cv-1110, WDTX, October 26, 2021, 59 pages.	

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	First Named Inventor	Rune FISKER
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	Attorney Docket Number	0079124-000370-T1

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	Attorney Docket Number	0079124-000370-T1

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	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
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	Examiner Name	
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	Examiner Name	
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	96	LOGOZZO, et al., "Recent Advanced in Dental Optics - Part I: 3D Introoral Scanners for Restorative Dentistry", Optics and Lasers in Engineering, 2013, pp. 1-19.	☐
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	99	NITSCHKE, "Real-Time Space Carving Using Graphics Hardware", IEICE Transactions on Information and Systems, doi: 10 1093/ietisy/e90-d.8., 2007, pp. 1175-1184.	☐
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	104	REMONDINO, et al., "Image-Based 3D Modelling: A Review", The Photogrammetric Record, Volume 21, No. 115, September 2006, pp. 269-291.	☐

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

Based on USPTO Form PTO/SB/08

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Rune FISKER
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

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	109	SPENCER, et al., "General Ray-Tracing Procedure", Journal of the Optical Society of America, Volume 52, No. 6, June 1962, pp. 672-678.	☐
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	113	VEDULA, et al., "Shape and Motion Carving in 6D", Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2000, 7 pages.	☐
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	116	Notification Concerning Transmittal of Copy of International Preliminary Report on Patentability (Forms PCT/1 B/326 and PCT/18/373) and the Written Opinion of the International Searching Authority (Form PCT/ISA237) issued on January 5, 2012, in the corresponding international Application No, PCT/DK2010/050148.	☐

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	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

	117	Exhibit 2- 3D Imagery Handbook (Moria Ogami, Fii-st Edition, Feb. 20, 2006, pages 45-46 (4 pages).	☐
	118	Exhibit 6- Latest Optical 30 Measurement (Toru Yoshizawa, Fii-st Edition, Nov. 20, 2006, pages 45-46 (16 pages).	☐
	119	"Amended Complaint, 3Stlape A/S v. Align Tectinology, Inc., Case No. 1 :18-886-L.PS", August 30, 2019, 166 pages.	☐

IDENTIFICATION OF EARLIER APPLICATION UNDER 37 C.F.R. § 1.98(d)

Documents cited on this form were previously made of record in prior application Serial No. 17/340,806 filed on June 7, 2021, upon which the Applicant relies for the benefits provided in 35 U.S.C. § 120.

EXAMINER SIGNATURE

Examiner Signature	/JOSE M MESA/	Date Considered	02/02/2022

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.
[4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (2).

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	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/WCRowland/	Date (YYYY-MM-DD)	2021-11-23
Name/Print	William C. Rowland	Registration Number	30,888

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER et al.
Art Unit	2484
Examiner Name	Jose M. MESA
Attorney Docket Number	0079124-000370-T1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4781448		1988-01-01	Chatenenver et al.	
	2	5605459	A	1997-02-25	Kuroda et al.	
	3	5675407	A	1997-10-07	Geng	
	4	5702249	A	1997-12-30	Cooper	
	5	7077647	B2	2006-07-18	Choi et al.	
	6	7230771	B2	2007-06-12	Kuiper et al.	
	7	8571397	B2	2013-10-29	Liu et al.	
	8	10349042	B1	2019-07-09	Fisker et al.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	17533403
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First Named Inventor	Rune FISKER et al.
Art Unit	2484
Examiner Name	Jose M. MESA
Attorney Docket Number	0079124-000370-T1

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	1	20050237581	A1	2005-10-27	Knighton et al.	
	2	20060092133	A1	2006-05-04	Touma et al.	
	3	20060212260	A1	2006-09-21	Kopelman et al.	
	4	20070172112	A1	2007-07-26	Paley et al.	
	5	20100009308	A1	2010-01-14	Wen et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	3321866	JP	B2	2002-09-09	Hitachi Ltd.	(with English Translation)	X

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

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	First Named Inventor	Rune FISKER et al.
	Art Unit	2484
	Examiner Name	Jose M. MESA
	Attorney Docket Number	0079124-000370-T1

	1	Declaration of Lambertus Hesselink, Ph.D., Exhibit 1002.	
	2	Order, Lipocine Inc. v. Clarus Therapeutics, Inc., Case No. 1:19-cv-00622-WCB (November 12, 2020), Exhibit 1052.	
	3	Defendant Align Technology, Inc.'s Stipulation of Invalidity Contentions, 3Shape A/S v. Align Technology, Inc., Case No. 1:18-cv-00886-LPS (November 13, 2020), Exhibit 1053.	
	4	Transcript of July 16, 2021 Deposition of Alexander V. Sergienko, Ph.D., Exhibit 1056.	
	5	Reply Declaration of Lambertus Hesselink, Exhibit 1057.	
	6	Declaration of Alexander Sergienko, Ph.D. in 3Shape A/S et al. v. Align Technology, Inc., Case No. IPR2020-01622, Exhibit 1061.	
	7	Patent Owner's Preliminary Response to the Petition for Inter Partes Review of U.S. Patent No. 10,349,042, Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01088 (October 23, 2020), Exhibit 1062.	
	8	Petition for Inter Partes Review of U.S. Patent No. 8,363,228, 3Shape A/S et al. v. Align Technology, Inc., Case No. IPR2019-00157 (November 8, 2018), Exhibit 1063.	
	9	C.S. FRASER et al., "Zoom-Dependent Camera Calibration in Digital Close-Range Photogrammetry", Photogrammetric Engineering & Remote Sensing 72(9): 1017-1026 (September 2006), Exhibit 1064.	
	10	W.J. SMITH, "Modern Optical Engineering: The Design of Optical Systems", Third Edition, 2000, Exhibit 1065.	
	11	Declaration of Alexander Sergienko, Ph.D., Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01087, Exhibit 2019.	

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	Filing Date	2021-11-23
	First Named Inventor	Rune FISKER et al.
	Art Unit	2484
	Examiner Name	Jose M. MESA
	Attorney Docket Number	0079124-000370-T1

	12	Memorandum Order, C.A. No. 18-886-LPS (D. Del), December 28, 2020, Exhibit 2022.
	13	Deposition Transcript of Dr. Lambertus Hesselink taken April 2, 2021, Exhibit 2023.
	14	Reg G. Willson and Steven A. Shafer, "Dynamic Lens Compensation for Active Color Imaging and Constant Magnification Focusing", The Robotics Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213, November 1991 ("Willson"), Exhibit 2027.
	15	Trevor Darrell and Kwangyoen Wohn, "Pyramid Based Depth from Focus", Grasp Laboratory, Computer and Information Science, Univ. of Pennsylvania, Proceedings of Computer Vision and Pattern Recognition, Ann Arbor, Michigan, June 1988, Computer Society, IEEE Computer Society, pp. 504-509. ("Darrell"), Exhibit 2028.
	16	Declaration of Sylvia Hall-Ellis, Ph.D. with attachments, Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01087, Exhibit 2029.
	17	Deposition Transcript of Dr. Lambertus Hesselink taken September 10, 2021, Exhibit 2030.
	18	Final Written Decision, Align Technology, Inc. v. 3Shape A/S, IPR2020-01087, January 19, 2022.

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/JOSE M MESA/	Date Considered	02/08/2022

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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PE2E SEARCH - Search History (Prior Art)

There are no Prior Art searches to show.

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	13	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:24 PM
N3	22	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:26 PM
N4	50	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth object) WITH dimensions).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:26 PM
N5	16	(tim$4 SAME (var$4 chang$4 modif$4 alter$4) SAME (illuminat$4 light$4) SAME pattern SAME (teeth tooth) SAME dimensions)	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:27 PM
N6	13	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:28 PM
N7	22	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:28 PM
N8	72	(hollenbeck-karl-josef).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:29 PM
N9	20	(qazi-arish-a).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:29 PM
N10	62	(van-der-poel-mike).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:30 PM
N11	10	(kjaer-rasmus).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02

							01:31 PM
N12	59	(ojelund-henrik).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:31 PM
N13	201	(fisker-rune).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:32 PM

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/533,403	11/23/2021	Rune FISKER	0079124-000370-T1	9694

21839 7590 03/29/2022

BUCHANAN, INGERSOLL & ROONEY PC
1737 KING STREET
SUITE 500
ALEXANDRIA, VA 22314-2727

EXAMINER	
MESA, JOSE M	

ART UNIT	PAPER NUMBER
2484	

NOTIFICATION DATE	DELIVERY MODE
03/29/2022	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ADIPDOC1@BIPC.com

Corrected ***Notice of Allowability***	**Application No.** 17/533,403	**Applicant(s)** FISKER et al.	
	Examiner JOSE M MESA	**Art Unit** 2484	**AIA (FITF) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 11/23/2021.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 2-20 and 23-33 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 11/23/2021 01/05/2022 02/02/2022.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/JOSE M MESA/ Examiner, Art Unit 2484	/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Terminal Disclaimer

The terminal disclaimers filed on 02/02/2022 and 02/22/2022 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of U.S. Patent No. 11,076,146 and U.S. Patent No. 10,595,010 have been reviewed and are accepted. The terminal disclaimers have been recorded.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with William C. Rowland on 03/11/2022. In the examiner's amendment claim 22 is amended to correct a typographical error, wherein claim 22 now depends on claim 15 as shown below.

22. (Currently Amended) The handheld intraoral scanner according to claim 15, wherein the hardware processor is further configured to selectively switch the color of the probe light by switching on and off the at least three monochromatic light sources.

Allowable Subject Matter

1. Claims 2-20 and 22-33 are allowed.

The following is an examiner's statement of reasons for allowance: **Independent claim 2** recites the uniquely distinct features for: "...a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern; an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;..." **And independent claim 15** recites the uniquely distinct features for: "...a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern; an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern,..." **And independent claim 28** recites the uniquely distinct features for: "...a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern; an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the

3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;..." The closest prior art in Babayoff et al. (US 2005/0283065) teaches a device 100 comprises a main illumination source 31 for illuminating the object of interest 26, typically a part of the intraoral cavity, and is optically coupled to main optics 41 to provide depth Z values for an array range of X-Y points (according to a known frame of reference) along the surface of the object 26. Detection optics 60 comprises an image sensor, typically a CCD, that is preferably monochromatic to maximise the resolution of the device, and which typically defines the X-Y frame of reference. Alternatively, the CCD may be adapted to receive color images. The detection optics 60 receives image data from the main optics 41 and the image processor 24 determines the depth Z values for each X-Y point illuminated on the object 26 based on this image data, Heinz et al. (US 2007/0041729) teaches an illustrative illumination arrangement 800 using a multimode optical fiber 802 to monitor a surface 804 with a detector 805 (e.g., detector 104 of FIG. 1, detector 302 of FIG. 3A, or detector A of FIG. 7, 7A). Optical radiation 806 that reflects from surface 804 will exhibit time-varying changes if surface 804 vibrates, if fiber 802 moves across surface 804, or if distance d changes (e.g., through tilt or movement of surface 804). The multimode interference pattern that illuminates detector 805 is time-varying in accordance with the movement of surface 804 (or end 814 or d), however, either singular or in combination, fails to anticipate or render the above underlined limitations obvious.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSE M MESA whose telephone number is (571)270-1706. The examiner can normally be reached on Monday-Friday 8:30AM-6:00PM ET.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thai Tran can be reached on 571-272-7382. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

2/2/2022

/JOSE M MESA/
Examiner, Art Unit 2484

/THAI Q TRAN/
Supervisory Patent Examiner, Art Unit 2484

Notice of References Cited	Application/Control No. 17/533,403	Applicant(s)/Patent Under Reexamination FISKER et al.	
	Examiner JOSE M MESA	Art Unit 2484	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20050283065-A1	12-2005	Babayoff, Noam	A61C9/0066	600/407
*	B	US-20070041729-A1	02-2007	Heinz; Philip	H01L31/02024	398/25
	C					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	Art Unit
	JOSE M MESA	2484

CPC - Searched*		
Symbol	Date	Examiner
H04N13/296, A61B5/0068, A61B5/1077, G01B11/2513, G01B11/2518, A61B5/1075, A61B5/1076, A61B5/4547, G01B2210/58	02/02/2022	JM

CPC Combination Sets - Searched*		
Symbol	Date	Examiner
H04N13/296, A61B5/0068, A61B5/1077, G01B11/2513, G01B11/2518, A61B5/1075, A61B5/1076, A61B5/4547, G01B2210/58	02/02/2022	JM

US Classification - Searched*			
Class	Subclass	Date	Examiner
348		02/02/2022	JM

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
PE2E Search History, US-PGPUB, USPAT, USOCR, FIT, EPO, JPO, DERWENT, IBM_TDB.	02/02/2022	JM
Searched inventor's name in PALM and PE2E for double patenting.	02/02/2022	JM

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	See PE2E Search History for interference search.	02/02/2022	JM

/JOSE M MESA/ Examiner, Art Unit 2484	/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484

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DENTAL IMAGING

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	**Art Unit**
	JOSE M MESA	2484

CPC						
Symbol					**Type**	**Version**
H04N	/	13	/	296	F	2018-05-01
A61B	/	5	/	0068	I	2013-01-01
G01B	/	11	/	2513	I	2013-01-01
G01B	/	11	/	2518	I	2013-01-01
A61B	/	5	/	1077	I	2013-01-01
A61B	/	5	/	4547	A	2013-01-01
G01B	/	2210	/	58	A	2013-01-01
A61B	/	5	/	1075	A	2013-01-01
A61B	/	5	/	1076	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
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/JOSE M MESA/ Examiner, Art Unit 2484	11 March 2022	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	31	
/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484	16 March 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	2	8

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	**Art Unit**
	JOSE M MESA	2484

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04N	/	13	/	296

NON-CLAIMED				
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US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

/JOSE M MESA/ Examiner, Art Unit 2484 (Assistant Examiner)	11 March 2022 (Date)	**Total Claims Allowed:** 31	
/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484 (Primary Examiner)	16 March 2022 (Date)	O.G. Print Claim(s) 2	O.G. Print Figure 8

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	**Art Unit**
	JOSE M MESA	2484

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
-	1	9	10	18	19	26	28								
1	2	10	11	19	20	27	29								
2	3	11	12	-	21	28	30								
3	4	12	13	20	22	29	31								
4	5	13	14	21	23	30	32								
5	6	14	15	22	24	31	33								
6	7	15	16	23	25										
7	8	16	17	24	26										
8	9	17	18	25	27										

/JOSE M MESA/ Examiner, Art Unit 2484	11 March 2022	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	31	
/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484	16 March 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	2	8

U.S. Patent and Trademark Office

Part of Paper No.: 20220311

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DENTAL IMAGING

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	Art Unit
	JOSE M MESA	2484

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/02/2022								
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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER
Art Unit	
Examiner Name	
Attorney Docket Number	0079124-000370-T1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	RE48,221	E	2020-09-22	ÖJELUND, ET AL.	
	2	10695151	B1	2020-06-30	ESBECH, ET AL.	
	3	11076146	B1	2021-07-27	FISKER, ET AL.	

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	1							

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER
Art Unit	
Examiner Name	
Attorney Docket Number	0079124-000370-T1

If you wish to add additional Foreign Patent Document citation information please click the Add button [Add]

NON-PATENT LITERATURE DOCUMENTS [Remove]

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	COMPLAINT, 3Shape A/S v. Carestream Dental, LLC, Civil Action No. 6:21-cv-1110, WDTX, October 26, 2021, 59 pages.	

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature	/JOSE M MESA/	Date Considered	02/02/2022

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

PE2E SEARCH - Search History (Prior Art)

There are no Prior Art searches to show.

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	13	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:24 PM
N3	22	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:26 PM
N4	50	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth object) WITH dimensions).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:26 PM
N5	16	(tim$4 SAME (var$4 chang$4 modif$4 alter$4) SAME (illuminat$4 light$4) SAME pattern SAME (teeth tooth) SAME dimensions)	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:27 PM
N6	13	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:28 PM
N7	22	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:28 PM
N8	72	(hollenbeck-karl-josef).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:29 PM
N9	20	(qazi-arish-a).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:29 PM
N10	62	(van-der-poel-mike).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:30 PM
N11	10	(kjaer-rasmus).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02

							01:31 PM
N12	59	(ojelund-henrik).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:31 PM
N13	201	(fisker-rune).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:32 PM

PE2E SEARCH - Search History (Prior Art)

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L1	1	(scan$4 scanner) near2 (color near2 probe near2 light)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:52 AM
L2	379	(scan$4 scanner) near50 (color near20 probe near20 light)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:52 AM
L3	47	L2 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:55 AM
L4	1484	(scan$4 scanner) SAME ((switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME probe SAME light SAME object)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 11:56 AM

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DENTAL IMAGING

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L5	112	L4 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:57 AM
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L7	74	L6 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:58 AM
L8	1008	((scan$4 scanner) SAME color SAME (images frames pictures) SAME probe	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/02/02 11:59 AM

		SAME light SAME surface SAME object)	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L9	94	L8 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:59 AM
L10	2645	((switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME (images frames pictures) SAME probe SAME light SAME object)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:00 PM
L11	118	L10 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:01 PM
L12	4446	((switch$4 chang$4	(US-PGPUB; USPAT;	OR	ON	ON	2022/02/02

		modif$4 alter$4 adjust$4) SAME color SAME probe SAME light SAME object)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				12:02 PM
L13	288	L12 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:02 PM
L14	2688	(selectiv$4 SAME (switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME probe SAME light)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:09 PM
L15	44	L14 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/02/02 12:10 PM

			WO); EPO; JPO; DERWENT; IBM_TDB)				
L17	2170	((selectiv$4 select$4) SAME (switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME probe SAME light SAME (object tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:14 PM
L18	59	L17 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:14 PM
L19	84974	((selectiv$4 select$4) SAME (switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME light SAME (object tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:15 PM
L20	994712	("20030096210"|"20040080754"|"20050283065"|"20060158665"|"20070109559"|"20070194214"|"20070252074"|"20090103103"|"20090167948"|"20090279103"|"20100079581"|"20100157086"|"4291958"|"4349880"|"4516231"|"457580	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/02/02 12:21 PM

		5"|"4629324"|"4640620"|"4896015"|"5372502"|"5381236"|"5615003"|"6697164")".PN"	PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L21	2352	L19 AND L20	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:21 PM
L22	330	L19 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:21 PM
L23	741	L20 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:22 PM
L24	20	L21 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 12:22 PM

		A61B5/4547 G01B2210/58).CPC.	IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L25	320	(tim$4 near2 var$4 near2 illuminat$4 near2 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:24 PM
L26	9	L20 AND L25	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:25 PM
L27	239	L25 AND (scan$4 scanner)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:26 PM
L28	49	L25 AND (tooth teeth)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/02/02 12:27 PM

			CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L29	4046	(tim$4 near50 var$4 near50 illuminat$4 near50 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:28 PM
L30	258	L29 AND (tooth teeth)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:28 PM
L31	90	(segment$4 near50 ((led) light near2 emitting near2 diode) near50 scanner)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:34 PM
L32	95	(segment$4 near50	(US-PGPUB; USPAT;	OR	ON	ON	2022/02/02

		((led) light near2 emitting near2 diode) near50 probe near50 light)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				12:36 PM
L33	92	(segmented SAME ((led) light near2 emitting near2 diode) SAME probe SAME light)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:49 PM
L34	102	(optical near2 system near2 substantially near2 achromatic)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:50 PM
L35	67	(optical near50 system near50 substantially near50 achromatic near50 color)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/02/02 12:51 PM

			WO); EPO; JPO; DERWENT; IBM_TDB)				
L36	15	(optical SAME system SAME substantially SAME achromatic SAME (tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:53 PM
L37	144	(tim$4 near50 var$4 near50 illuminat$4 near50 line near50 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:54 PM
L38	492	(tim$4 near50 (var$4 chang$4) near50 illuminat$4 near50 line near50 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:55 PM
L39	20	L38 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/02/02 12:55 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L40	639	(tim$4 SAME (var$4 chang$4) SAME illuminat$4 SAME line SAME pattern SAME (tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:56 PM
L41	18	L40 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:56 PM
L42	894	(tim$4 same5 (var$4 chang$4) same5 illuminat$4 same5 (line adj5 pattern) same5 (tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:58 PM
L43	182	L42 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 12:58 PM

		A61B5/4547 G01B2210/58).CPC.	IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L44	857	(camera near2 two near2 cameras) near50 (tooth teeth)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:11 PM
L45	48	L44 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:12 PM
L46	109	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:14 PM
L47	219	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/02/02 01:15 PM

		WITH pattern WITH (teeth tooth))	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L48	17	L47 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:15 PM
L49	1091	(tim$4 SAME (var$4 chang$4 modif$4 alter$4) SAME (illuminat$4 light$4) SAME pattern SAME (teeth tooth) SAME dimensions)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:16 PM
L50	20	L49 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:16 PM
L51	292	(tim$4 WITH (var$4	(US-PGPUB; USPAT;	OR	ON	ON	2022/02/02

		chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth object) WITH dimensions)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				01:16 PM
L52	8	L51 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:17 PM
L53	292	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth object) WITH dimensions)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:19 PM
L54	8	L53 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/02/02 01:19 PM

			WO); EPO; JPO; DERWENT; IBM_TDB)				
L55	1091	(tim$4 SAME (var$4 chang$4 modif$4 alter$4) SAME (illuminat$4 light$4) SAME pattern SAME (teeth tooth) SAME dimensions)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:19 PM
L56	20	L55 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:20 PM
L57	109	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:20 PM
L58	219	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/02/02 01:20 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L59	17	L58 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:21 PM
L60	435	(fisker-rune).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:21 PM
L61	91	(ojelund-henrik).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:22 PM
L62	25	(kjaer-rasmus).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 01:22 PM

			IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L63	108	(van-der-poel-mike).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:23 PM
L64	33	(qazi-arish-a).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:23 PM
L65	151	(hollenbeck-karl-josef).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:23 PM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER et al.
Art Unit	2484
Examiner Name	Jose M. MESA
Attorney Docket Number	0079124-000370-T1

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4781448		1988-01-01	Chatenenver et al.	
	2	5605459	A	1997-02-25	Kuroda et al.	
	3	5675407	A	1997-10-07	Geng	
	4	5702249	A	1997-12-30	Cooper	
	5	7077647	B2	2006-07-18	Choi et al.	
	6	7230771	B2	2007-06-12	Kuiper et al.	
	7	8571397	B2	2013-10-29	Liu et al.	
	8	10349042	B1	2019-07-09	Fisker et al.	

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Examiner Name	Jose M. MESA
Attorney Docket Number	0079124-000370-T1

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20050237581	A1	2005-10-27	Knighton et al.	
	2	20060092133	A1	2006-05-04	Touma et al.	
	3	20060212260	A1	2006-09-21	Kopelman et al.	
	4	20070172112	A1	2007-07-26	Paley et al.	
	5	20100009308	A1	2010-01-14	Wen et al.	

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	1	3321866	JP	B2	2002-09-09	Hitachi Ltd.	(with English Translation)	X

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	Art Unit	2484
	Examiner Name	Jose M. MESA
	Attorney Docket Number	0079124-000370-T1

	1	Declaration of Lambertus Hesselink, Ph.D., Exhibit 1002.	
	2	Order, Lipocine Inc. v. Clarus Therapeutics, Inc., Case No. 1:19-cv-00622-WCB (November 12, 2020), Exhibit 1052.	
	3	Defendant Align Technology, Inc.'s Stipulation of Invalidity Contentions, 3Shape A/S v. Align Technology, Inc., Case No. 1:18-cv-00886-LPS (November 13, 2020), Exhibit 1053.	
	4	Transcript of July 16, 2021 Deposition of Alexander V. Sergienko, Ph.D., Exhibit 1056.	
	5	Reply Declaration of Lambertus Hesselink, Exhibit 1057.	
	6	Declaration of Alexander Sergienko, Ph.D. in 3Shape A/S et al. v. Align Technology, Inc., Case No. IPR2020-01622, Exhibit 1061.	
	7	Patent Owner's Preliminary Response to the Petition for Inter Partes Review of U.S. Patent No. 10,349,042, Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01088 (October 23, 2020), Exhibit 1062.	
	8	Petition for Inter Partes Review of U.S. Patent No. 8,363,228, 3Shape A/S et al. v. Align Technology, Inc., Case No. IPR2019-00157 (November 8, 2018), Exhibit 1063.	
	9	C.S. FRASER et al., "Zoom-Dependent Camera Calibration in Digital Close-Range Photogrammetry", Photogrammetric Engineering & Remote Sensing 72(9): 1017-1026 (September 2006), Exhibit 1064.	
	10	W.J. SMITH, "Modern Optical Engineering: The Design of Optical Systems", Third Edition, 2000, Exhibit 1065.	
	11	Declaration of Alexander Sergienko, Ph.D., Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01087, Exhibit 2019.	

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	Examiner Name	Jose M. MESA
	Attorney Docket Number	0079124-000370-T1

	12	Memorandum Order, C.A. No. 18-886-LPS (D. Del), December 28, 2020, Exhibit 2022.
	13	Deposition Transcript of Dr. Lambertus Hesselink taken April 2, 2021, Exhibit 2023.
	14	Reg G. Willson and Steven A. Shafer, "Dynamic Lens Compensation for Active Color Imaging and Constant Magnification Focusing", The Robotics Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213, November 1991 ("Willson"), Exhibit 2027.
	15	Trevor Darrell and Kwangyoen Wohn, "Pyramid Based Depth from Focus", Grasp Laboratory, Computer and Information Science, Univ. of Pennsylvania, Proceedings of Computer Vision and Pattern Recognition, Ann Arbor, Michigan, June 1988, Computer Society, IEEE Computer Society, pp. 504-509. ("Darrell"), Exhibit 2028.
	16	Declaration of Sylvia Hall-Ellis, Ph.D. with attachments, Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01087, Exhibit 2029.
	17	Deposition Transcript of Dr. Lambertus Hesselink taken September 10, 2021, Exhibit 2030.
	18	Final Written Decision, Align Technology, Inc. v. 3Shape A/S, IPR2020-01087, January 19, 2022.

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Examiner Signature	/JOSE M MESA/	Date Considered	02/08/2022

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	First Named Inventor	Rune FISKER
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
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	2	7221332	B2	2007-05-22	Miller et al.	
	3	5377011	A	1994-12-27	Koch	
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	5	5131844	A	1992-07-21	Marinaccio et al.	
	6	6592371	B2	2003-07-15	Durbin et al.	
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	8	6645148	B2	2003-11-11	Nguyen-Dinh et al.	
	9	5181181	A	1993-01-19	Glynn	
	10	6227850	B1	2001-05-08	Chishti et al.	
	11	7213214	B2	2007-05-01	Baar et al.	
	12	7551353	B2	2009-06-23	Kim et al.	
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	14	7813591	B2	2010-10-12	Paley et al.	
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	16	4575805		1986-03-11	Moermann et al.	
	17	6697164	B1	2004-02-24	Babayoff	
	18	5615003	A	1997-03-25	Hermary	
	19	5372502	A	1994-12-13	Massen	
	20	4349880	A	1982-09-14	Southgate	
	21	4291958	A	1981-09-29	Frank	

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	First Named Inventor	Rune FISKER
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

	22	4896015	A	1990-01-23	Taboada et al.	
	23	4516231		1985-05-07	Michaelis	
	24	4629324		1985-12-16	Stern	
	25	4640620		1987-02-03	Schmidt	
	26	5381236		1995-01-10	Morgan	
	27	5737339		1998-04-07	Goto et al.	
	28	5428450		1995-06-27	Vieillefosse et al.	
	29	4575805		1986-03-11	Moermann et al.	
	30	5455899		1995-10-03	Forslund	
	31	6227850		2001-05-08	Chishti et al.	
	32	3971065		1976-07-20	Bayer, Bryce E	
	33	5151609	A	1992-09-29	Nakagawa, et al.	
	34	5339154	A	1994-08-16	Gassler, et al.	
	35	6026189	A	2000-02-15	Greenspan, Michael	
	36	6148120	A	2000-11-14	Sussman, Michael	
	37	6229913	B1	2001-05-08	Nayar, et al.	
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	39	6263234	B1	2001-07-17	Engelhardt, et al.	
	40	6334853	B1	2002-01-01	Kopelman, et al.	
	41	6476803	B1	2002-11-05	Zhang, et al.	
	42	6750873	B1	2004-06-15	Bernardini, et al.	
	43	6865289	B1	2005-03-08	Berestov, Alexander	
	44	6904159	B2	2005-06-07	Porikli, Faith M	

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	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Rune FISKER
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

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	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

Based on USPTO Form PTO/SB/08

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Rune FISKER
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

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	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Rune FISKER
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	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

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IDENTIFICATION OF EARLIER APPLICATION UNDER 37 C.F.R. § 1.98(d)

Documents cited on this form were previously made of record in prior application Serial No. 17/340,806 filed on June 7, 2021, upon which the Applicant relies for the benefits provided in 35 U.S.C. § 120.

EXAMINER SIGNATURE

Examiner Signature	/JOSE M MESA/	Date Considered	02/02/2022

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.
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CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (2).

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	Filing Date	
	First Named Inventor	Rune FISKER
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/WCRowland/	Date (YYYY-MM-DD)	2021-11-23
Name/Print	William C. Rowland	Registration Number	30,888

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /LM/

Bibliographic Data

Application No: 17/533,403

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /JOSE M MESA/ (Examiner's Signature) ____ (Initials)

Title: FOCUS SCANNING APPARATUS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/23/2021	348	2484	0079124-000370-T1
RULE			

APPLICANTS

3SHAPE A/S, Copenhagen K, DENMARK

INVENTORS

Rune FISKER, Virum, DENMARK

Henrik ÖJELUND, Lyngby, DENMARK

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Mike VAN DER POEL, Rodovre, DENMARK

Arish A. QAZI, Toronto, CANADA

Karl-Josef HOLLENBECK, Copenhagen O, DENMARK

CONTINUING DATA

This application is a CON of 17340806 06/07/2021

17340806 is a CON of 17206581 03/19/2021 PAT 11076146

17206581 is a CON of 16774843 01/28/2020 PAT 11051002

16774843 is a CON of 16433369 06/06/2019 PAT 10595010

16433369 is a CON of 16217943 12/12/2018 PAT 10326982

16217943 is a CON of 15974105 05/08/2018 PAT 10349041

15974105 is a CON of 14502230 09/30/2014 PAT 10097815

14502230 is a CON of 13376427 12/06/2011 PAT 8878905

13376427 is a 371 of PCT/DK2010/050148 06/17/2010

PCT/DK2010/050148 has PRO of 61231118 08/04/2009

PCT/DK2010/050148 has PRO of 61187744 06/17/2009

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

12/06/2021

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/533,403	11/23/2021	Rune FISKER	0079124-000370-T1

CONFIRMATION NO. 9694

21839
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1737 KING STREET
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ALEXANDRIA, VA 22314-2727

PUBLICATION NOTICE

OC000000132531215

Title:FOCUS SCANNING APPARATUS

Publication No.US-2022-0086418-A1
Publication Date:03/17/2022

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

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(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/533,403	11/23/2021	Rune FISKER	0079124-000370-T1	9694

TITLE OF INVENTION: FOCUS SCANNING APPARATUS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	06/08/2022

EXAMINER	ART UNIT	CLASS-SUBCLASS
MESA, JOSE M	2484	348-046000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 BUCHANAN INGERSOLL
2 & ROONEY PC
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: 3Shape A/S

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Kobenhavn K, DENMARK

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 02-4800

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /WCRowland/ Date March 8, 2022

Typed or printed name William C. Rowland Registration No. 30,888

Exhibit 1004 page 1327 of 1621
DENTAL IMAGING

Electronic Patent Application Fee Transmittal

Application Number:	17533403
Filing Date:	23-Nov-2021
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Filer:	William C. Rowland/Stacey Pflieger
Attorney Docket Number:	0079124-000370-T1

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1200	1200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1200**

Electronic Acknowledgement Receipt

EFS ID:	45171485
Application Number:	17533403
International Application Number:	
Confirmation Number:	9694
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Customer Number:	21839
Filer:	William C. Rowland/Stacey Pflieger
Filer Authorized By:	William C. Rowland
Attorney Docket Number:	0079124-000370-T1
Receipt Date:	08-MAR-2022
Filing Date:	23-NOV-2021
Time Stamp:	12:35:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1200
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	370if.pdf	558814 16e72c73a2e06123293c9687dfa05c92c53b1fea	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37717 49070138447a707438986f7dbce97e8121396035	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	596531		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

21839 7590 03/08/2022

BUCHANAN, INGERSOLL & ROONEY PC
1737 KING STREET
SUITE 500
ALEXANDRIA, VA 22314-2727

EXAMINER
MESA, JOSE M

ART UNIT	PAPER NUMBER
2484	

DATE MAILED: 03/08/2022

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/533,403	11/23/2021	Rune FISKER	0079124-000370-T1	9694

TITLE OF INVENTION: FOCUS SCANNING APPARATUS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	06/08/2022

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

21839 7590 03/08/2022

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1737 KING STREET
SUITE 500
ALEXANDRIA, VA 22314-2727

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/533,403	11/23/2021	Rune FISKER	0079124-000370-T1	9694

TITLE OF INVENTION: FOCUS SCANNING APPARATUS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	06/08/2022

EXAMINER	ART UNIT	CLASS-SUBCLASS
MESA, JOSE M	2484	348-046000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

Exhibit 1004 page 1333 of 1621
DENTAL IMAGING

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/533,403	11/23/2021	Rune FISKER	0079124-000370-T1	9694

21839 7590 03/08/2022

BUCHANAN, INGERSOLL & ROONEY PC
1737 KING STREET
SUITE 500
ALEXANDRIA, VA 22314-2727

EXAMINER	
MESA, JOSE M	

ART UNIT	PAPER NUMBER
2484	

DATE MAILED: 03/08/2022

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 17/533,403	Applicant(s) FISKER et al.	
	Examiner JOSE M MESA	Art Unit 2484	AIA (FITF) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 11/23/2021.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 2-20 and 22-33 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 11/23/2021 01/05/2022 02/02/2022.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/JOSE M MESA/ Examiner, Art Unit 2484	/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Terminal Disclaimer

The terminal disclaimers filed on 02/02/2022 and 02/22/2022 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of U.S. Patent No. 11,076,146 and U.S. Patent No. 10,595,010 have been reviewed and are accepted. The terminal disclaimers have been recorded.

Allowable Subject Matter

1. Claims 2-20 and 22-33 are allowed.

The following is an examiner's statement of reasons for allowance: **Independent claim 2** recites the uniquely distinct features for: "...a patiern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern; an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;..." **And independent claim 15** recites the uniquely distinct features for: "...a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern; an optical system configured to transmit the probe light, via the tip,

towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern,..." **And independent claim 28** recites the uniquely distinct features for: "...a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern; an optical system configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern;..." The closest prior art in Babayoff et al. (US 2005/0283065) teaches a device 100 comprises a main illumination source 31 for illuminating the object of interest 26, typically a part of the intraoral cavity, and is optically coupled to main optics 41 to provide depth Z values for an array range of X-Y points (according to a known frame of reference) along the surface of the object 26. Detection optics 60 comprises an image sensor, typically a CCD, that is preferably monochromatic to maximise the resolution of the device, and which typically defines the X-Y frame of reference. Alternatively, the CCD may be adapted to receive color images. The detection optics 60 receives image data from the main optics 41 and the image processor 24 determines the depth Z values for each X-Y point illuminated on the object 26 based on this image data, Heinz et al. (US 2007/0041729) teaches an illustrative illumination arrangement 800 using a multimode optical fiber 802 to monitor a surface 804 with a detector 805 (e.g., detector 104 of FIG. 1,

detector 302 of FIG. 3A, or detector A of FIG. 7, 7A). Optical radiation 806 that reflects from surface 804 will exhibit time-varying changes if surface 804 vibrates, if fiber 802 moves across surface 804, or if distance d changes (e.g., through tilt or movement of surface 804). The multimode interference pattern that illuminates detector 805 is time-varying in accordance with the movement of surface 804 (or end 814 or d), however, either singular or in combination, fails to anticipate or render the above underlined limitations obvious.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSE M MESA whose telephone number is (571)270-1706. The examiner can normally be reached on Monday-Friday 8:30AM-6:00PM ET.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thai Tran can be reached on 571-272-7382. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a

USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

2/2/2022

/JOSE M MESA/
Examiner, Art Unit 2484

/THAI Q TRAN/
Supervisory Patent Examiner, Art Unit 2484

Notice of References Cited	Application/Control No. 17/533,403	Applicant(s)/Patent Under Reexamination FISKER et al.	
	Examiner JOSE M MESA	Art Unit 2484	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20050283065-A1	12-2005	Babayoff, Noam	A61C9/0066	600/407
*	B	US-20070041729-A1	02-2007	Heinz; Philip	H01L31/02024	398/25
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	Art Unit
	JOSE M MESA	2484

CPC - Searched*		
Symbol	Date	Examiner
H04N13/296, A61B5/0068, A61B5/1077, G01B11/2513, G01B11/2518, A61B5/1075, A61B5/1076, A61B5/4547, G01B2210/58	02/02/2022	JM

CPC Combination Sets - Searched*		
Symbol	Date	Examiner
H04N13/296, A61B5/0068, A61B5/1077, G01B11/2513, G01B11/2518, A61B5/1075, A61B5/1076, A61B5/4547, G01B2210/58	02/02/2022	JM

US Classification - Searched*			
Class	Subclass	Date	Examiner
348		02/02/2022	JM

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
PE2E Search History, US-PGPUB, USPAT, USOCR, FIT, EPO, JPO, DERWENT, IBM_TDB.	02/02/2022	JM
Searched inventor's name in PALM and PE2E for double patenting.	02/02/2022	JM

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	See PE2E Search History for interference search.	02/02/2022	JM

/JOSE M MESA/ Examiner, Art Unit 2484	/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484

Exhibit 1004 page 1342 of 1621
DENTAL IMAGING

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	**Art Unit**
	JOSE M MESA	2484

CPC						
Symbol					**Type**	**Version**
H04N	/	13	/	296	F	2018-05-01
A61B	/	5	/	0068	I	2013-01-01
G01B	/	11	/	2513	I	2013-01-01
G01B	/	11	/	2518	I	2013-01-01
A61B	/	5	/	1077	I	2013-01-01
A61B	/	5	/	4547	A	2013-01-01
G01B	/	2210	/	58	A	2013-01-01
A61B	/	5	/	1075	A	2013-01-01
A61B	/	5	/	1076	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

/JOSE M MESA/ Examiner, Art Unit 2484 (Assistant Examiner)	02 February 2022 (Date)	**Total Claims Allowed:** 31	
/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484 (Primary Examiner)	28 February 2022 (Date)	O.G. Print Claim(s) 2	O.G. Print Figure 8

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	**Art Unit**
	JOSE M MESA	2484

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04N	/	13	/	296

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

/JOSE M MESA/ Examiner, Art Unit 2484 (Assistant Examiner)	02 February 2022 (Date)	**Total Claims Allowed:** 31	
/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484 (Primary Examiner)	28 February 2022 (Date)	O.G. Print Claim(s) 2	O.G. Print Figure 8

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	**Art Unit**
	JOSE M MESA	2484

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
-	1	9	10	18	19	26	28								
1	2	10	11	19	20	27	29								
2	3	11	12	-	21	28	30								
3	4	12	13	20	22	29	31								
4	5	13	14	21	23	30	32								
5	6	14	15	22	24	31	33								
6	7	15	16	23	25										
7	8	16	17	24	26										
8	9	17	18	25	27										

/JOSE M MESA/ Examiner, Art Unit 2484 (Assistant Examiner)	02 February 2022 (Date)	**Total Claims Allowed:** 31	
/THAI Q TRAN/ Supervisory Patent Examiner, Art Unit 2484 (Primary Examiner)	28 February 2022 (Date)	O.G. Print Claim(s) 2	O.G. Print Figure 8

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/533,403	FISKER et al.
	Examiner	Art Unit
	JOSE M MESA	2484

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/02/2022								
	1	-								
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	33	=								

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER et al.
Art Unit	2484
Examiner Name	Jose M. MESA
Attorney Docket Number	0079124-000370-T1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4781448		1988-01-01	Chatenenver et al.	
	2	5605459	A	1997-02-25	Kuroda et al.	
	3	5675407	A	1997-10-07	Geng	
	4	5702249	A	1997-12-30	Cooper	
	5	7077647	B2	2006-07-18	Choi et al.	
	6	7230771	B2	2007-06-12	Kuiper et al.	
	7	8571397	B2	2013-10-29	Liu et al.	
	8	10349042	B1	2019-07-09	Fisker et al.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
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First Named Inventor	Rune FISKER et al.
Art Unit	2484
Examiner Name	Jose M. MESA
Attorney Docket Number	0079124-000370-T1

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20050237581	A1	2005-10-27	Knighton et al.	
	2	20060092133	A1	2006-05-04	Touma et al.	
	3	20060212260	A1	2006-09-21	Kopelman et al.	
	4	20070172112	A1	2007-07-26	Paley et al.	
	5	20100009308	A1	2010-01-14	Wen et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	3321866	JP	B2	2002-09-09	Hitachi Ltd.	(with English Translation)	X

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17533403
	Filing Date	2021-11-23
	First Named Inventor	Rune FISKER et al.
	Art Unit	2484
	Examiner Name	Jose M. MESA
	Attorney Docket Number	0079124-000370-T1

	1	Declaration of Lambertus Hesselink, Ph.D., Exhibit 1002.	
	2	Order, Lipocine Inc. v. Clarus Therapeutics, Inc., Case No. 1:19-cv-00622-WCB (November 12, 2020), Exhibit 1052.	
	3	Defendant Align Technology, Inc.'s Stipulation of Invalidity Contentions, 3Shape A/S v. Align Technology, Inc., Case No. 1:18-cv-00886-LPS (November 13, 2020), Exhibit 1053.	
	4	Transcript of July 16, 2021 Deposition of Alexander V. Sergienko, Ph.D., Exhibit 1056.	
	5	Reply Declaration of Lambertus Hesselink, Exhibit 1057.	
	6	Declaration of Alexander Sergienko, Ph.D. in 3Shape A/S et al. v. Align Technology, Inc., Case No. IPR2020-01622, Exhibit 1061.	
	7	Patent Owner's Preliminary Response to the Petition for Inter Partes Review of U.S. Patent No. 10,349,042, Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01088 (October 23, 2020), Exhibit 1062.	
	8	Petition for Inter Partes Review of U.S. Patent No. 8,363,228, 3Shape A/S et al. v. Align Technology, Inc., Case No. IPR2019-00157 (November 8, 2018), Exhibit 1063.	
	9	C.S. FRASER et al., "Zoom-Dependent Camera Calibration in Digital Close-Range Photogrammetry", Photogrammetric Engineering & Remote Sensing 72(9): 1017-1026 (September 2006), Exhibit 1064.	
	10	W.J. SMITH, "Modern Optical Engineering: The Design of Optical Systems", Third Edition, 2000, Exhibit 1065.	
	11	Declaration of Alexander Sergienko, Ph.D., Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01087, Exhibit 2019.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17533403
	Filing Date	2021-11-23
	First Named Inventor	Rune FISKER et al.
	Art Unit	2484
	Examiner Name	Jose M. MESA
	Attorney Docket Number	0079124-000370-T1

	12	Memorandum Order, C.A. No. 18-886-LPS (D. Del), December 28, 2020, Exhibit 2022.
	13	Deposition Transcript of Dr. Lambertus Hesselink taken April 2, 2021, Exhibit 2023.
	14	Reg G. Willson and Steven A. Shafer, "Dynamic Lens Compensation for Active Color Imaging and Constant Magnification Focusing", The Robotics Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213, November 1991 ("Willson"), Exhibit 2027.
	15	Trevor Darrell and Kwangyoen Wohn, "Pyramid Based Depth from Focus", Grasp Laboratory, Computer and Information Science, Univ. of Pennsylvania, Proceedings of Computer Vision and Pattern Recognition, Ann Arbor, Michigan, June 1988, Computer Society, IEEE Computer Society, pp. 504-509. ("Darrell"), Exhibit 2028.
	16	Declaration of Sylvia Hall-Ellis, Ph.D. with attachments, Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01087, Exhibit 2029.
	17	Deposition Transcript of Dr. Lambertus Hesselink taken September 10, 2021, Exhibit 2030.
	18	Final Written Decision, Align Technology, Inc. v. 3Shape A/S, IPR2020-01087, January 19, 2022.

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EXAMINER SIGNATURE

Examiner Signature	/JOSE M MESA/	Date Considered	02/08/2022

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	1	(scan$4 scanner) near2 (color near2 probe near2 light)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:52 AM
L2	379	(scan$4 scanner) near50 (color near20 probe near20 light)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:52 AM
L3	47	L2 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:55 AM
L4	1484	(scan$4 scanner) SAME ((switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME probe SAME light SAME object)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 11:56 AM

Exhibit 1004 page 1351 of 1621
DENTAL IMAGING

			IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); EPO; JPO; DERWENT; IBM_TDB)				
L5	112	L4 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:57 AM
L6	1312	(scan$4 scanner) SAME ((switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME (images frames pictures) SAME probe SAME light SAME object)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:58 AM
L7	74	L6 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:58 AM
L8	1008	((scan$4 scanner) SAME color SAME (images frames pictures) SAME probe	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/02/02 11:59 AM

		SAME light SAME surface SAME object)	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L9	94	L8 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 11:59 AM
L10	2645	((switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME (images frames pictures) SAME probe SAME light SAME object)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:00 PM
L11	118	L10 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:01 PM
L12	4446	((switch$4 chang$4	(US-PGPUB; USPAT;	OR	ON	ON	2022/02/02

		modif$4 alter$4 adjust$4) SAME color SAME probe SAME light SAME object)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				12:02 PM
L13	288	L12 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:02 PM
L14	2688	(selectiv$4 SAME (switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME probe SAME light)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:09 PM
L15	44	L14 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/02/02 12:10 PM

			WO); EPO; JPO; DERWENT; IBM_TDB)				
L17	2170	((selectiv$4 select$4) SAME (switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME probe SAME light SAME (object tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:14 PM
L18	59	L17 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:14 PM
L19	84974	((selectiv$4 select$4) SAME (switch$4 chang$4 modif$4 alter$4 adjust$4) SAME color SAME light SAME (object tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:15 PM
L20	994712	("20030096210"|"20040080754"|"20050283065"|"20060158665"|"20070109559"|"20070194214"|"20070252074"|"20090103103"|"20090167948"|"20090279103"|"20100079581"|"20100157086"|"4291958"|"4349880"|"4516231"|"457580	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/02/02 12:21 PM

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DENTAL IMAGING

		5"|"4629324"|"4640620"|"4896015"|"5372502"|"5381236"|"5615003"|"6697164")".PN"	PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L21	2352	L19 AND L20	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:21 PM
L22	330	L19 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:21 PM
L23	741	L20 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:22 PM
L24	20	L21 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 12:22 PM

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DENTAL IMAGING

		A61B5/4547 G01B2210/58).CPC.	IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L25	320	(tim$4 near2 var$4 near2 illuminat$4 near2 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:24 PM
L26	9	L20 AND L25	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:25 PM
L27	239	L25 AND (scan$4 scanner)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:26 PM
L28	49	L25 AND (tooth teeth)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/02/02 12:27 PM

			CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L29	4046	(tim$4 near50 var$4 near50 illuminat$4 near50 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:28 PM
L30	258	L29 AND (tooth teeth)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:28 PM
L31	90	(segment$4 near50 ((led) light near2 emitting near2 diode) near50 scanner)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:34 PM
L32	95	(segment$4 near50	(US-PGPUB; USPAT;	OR	ON	ON	2022/02/02

		((led) light near2 emitting near2 diode) near50 probe near50 light)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				12:36 PM
L33	92	(segmented SAME ((led) light near2 emitting near2 diode) SAME probe SAME light)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:49 PM
L34	102	(optical near2 system near2 substantially near2 achromatic)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:50 PM
L35	67	(optical near50 system near50 substantially near50 achromatic near50 color)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/02/02 12:51 PM

			WO); EPO; JPO; DERWENT; IBM_TDB)				
L36	15	(optical SAME system SAME substantially SAME achromatic SAME (tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:53 PM
L37	144	(tim$4 near50 var$4 near50 illuminat$4 near50 line near50 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:54 PM
L38	492	(tim$4 near50 (var$4 chang$4) near50 illuminat$4 near50 line near50 pattern)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:55 PM
L39	20	L38 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/02/02 12:55 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L40	639	(tim$4 SAME (var$4 chang$4) SAME illuminat$4 SAME line SAME pattern SAME (tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:56 PM
L41	18	L40 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:56 PM
L42	894	(tim$4 same5 (var$4 chang$4) same5 illuminat$4 same5 (line adj5 pattern) same5 (tooth teeth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 12:58 PM
L43	182	L42 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 12:58 PM

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DENTAL IMAGING

		A61B5/4547 G01B2210/58).CPC.	IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L44	857	(camera near2 two near2 cameras) near50 (tooth teeth)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:11 PM
L45	48	L44 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:12 PM
L46	109	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:14 PM
L47	219	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/02/02 01:15 PM

		WITH pattern WITH (teeth tooth))	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L48	17	L47 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:15 PM
L49	1091	(tim$4 SAME (var$4 chang$4 modif$4 alter$4) SAME (illuminat$4 light$4) SAME pattern SAME (teeth tooth) SAME dimensions)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:16 PM
L50	20	L49 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:16 PM
L51	292	(tim$4 WITH (var$4	(US-PGPUB; USPAT;	OR	ON	ON	2022/02/02

		chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth object) WITH dimensions)	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				01:16 PM
L52	8	L51 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:17 PM
L53	292	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth object) WITH dimensions)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:19 PM
L54	8	L53 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2022/02/02 01:19 PM

			WO); EPO; JPO; DERWENT; IBM_TDB)				
L55	1091	(tim$4 SAME (var$4 chang$4 modif$4 alter$4) SAME (illuminat$4 light$4) SAME pattern SAME (teeth tooth) SAME dimensions)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:19 PM
L56	20	L55 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:20 PM
L57	109	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:20 PM
L58	219	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2022/02/02 01:20 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L59	17	L58 AND (H04N13/296 A61B5/0068 A61B5/1077 G01B11/2513 G01B11/2518 A61B5/1075 A61B5/1076 A61B5/4547 G01B2210/58).CPC.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:21 PM
L60	435	(fisker-rune).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:21 PM
L61	91	(ojelund-henrik).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:22 PM
L62	25	(kjaer-rasmus).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2022/02/02 01:22 PM

			IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)				
L63	108	(van-der-poel-mike).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:23 PM
L64	33	(qazi-arish-a).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:23 PM
L65	151	(hollenbeck-karl-josef).in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/02/02 01:23 PM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Rune FISKER
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
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	2	7221332	B2	2007-05-22	Miller et al.	
	3	5377011	A	1994-12-27	Koch	
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	23	4516231		1985-05-07	Michaelis	
	24	4629324		1985-12-16	Stern	
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T[5]
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Rune FISKER
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

	117	Exhibit 2- 3D Imagery Handbook (Moria Ogami, Fii-st Edition, Feb. 20, 2006, pages 45-46 (4 pages).	☐
	118	Exhibit 6- Latest Optical 30 Measurement (Toru Yoshizawa, Fii-st Edition, Nov. 20, 2006, pages 45-46 (16 pages).	☐
	119	"Amended Complaint, 3Stlape A/S v. Align Tectinology, Inc., Case No. 1 :18-886-L.PS", August 30, 2019, 166 pages.	☐

IDENTIFICATION OF EARLIER APPLICATION UNDER 37 C.F.R. § 1.98(d)

Documents cited on this form were previously made of record in prior application Serial No. 17/340,806 filed on June 7, 2021, upon which the Applicant relies for the benefits provided in 35 U.S.C. § 120.

EXAMINER SIGNATURE

Examiner Signature	/JOSE M MESA/	Date Considered	02/02/2022

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.
[4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (2).

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

Bibliographic Data

Application No: 17/533,403

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /JOSE M MESA/ (Examiner's Signature) | (Initials)

Title: FOCUS SCANNING APPARATUS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/23/2021	348	2484	0079124-000370-T1
RULE			

APPLICANTS

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Arish A. QAZI, Toronto, CANADA

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CONTINUING DATA

This application is a CON of 17340806 06/07/2021

17340806 is a CON of 17206581 03/19/2021 PAT 11076146

17206581 is a CON of 16774843 01/28/2020 PAT 11051002

16774843 is a CON of 16433369 06/06/2019 PAT 10595010

16433369 is a CON of 16217943 12/12/2018 PAT 10326982

16217943 is a CON of 15974105 05/08/2018 PAT 10349041

15974105 is a CON of 14502230 09/30/2014 PAT 10097815

14502230 is a CON of 13376427 12/06/2011 PAT 8878905

13376427 is a 371 of PCT/DK2010/050148 06/17/2010

PCT/DK2010/050148 has PRO of 61231118 08/04/2009

PCT/DK2010/050148 has PRO of 61187744 06/17/2009

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

12/06/2021

STATE OR COUNTRY

DENMARK

ADDRESS

BUCHANAN, INGERSOLL & ROONEY PC
1737 KING STREET
SUITE 500
ALEXANDRIA, VA 22314-2727
UNITED STATES

FILING FEE RECEIVED

$7,160

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER
Art Unit	
Examiner Name	
Attorney Docket Number	0079124-000370-T1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	RE48,221	E	2020-09-22	ÖJELUND, ET AL.	
	2	10695151	B1	2020-06-30	ESBECH, ET AL.	
	3	11076146	B1	2021-07-27	FISKER, ET AL.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	1							

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER
Art Unit	
Examiner Name	
Attorney Docket Number	0079124-000370-T1

If you wish to add additional Foreign Patent Document citation information please click the Add button [Add]

NON-PATENT LITERATURE DOCUMENTS [Remove]

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	COMPLAINT, 3Shape A/S v. Carestream Dental, LLC, Civil Action No. 6:21-cv-1110, WDTX, October 26, 2021, 59 pages.	

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature	/JOSE M MESA/	Date Considered	02/02/2022

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.M.M/

PE2E SEARCH - Search History (Prior Art)

There are no Prior Art searches to show.

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	13	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:24 PM
N3	22	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:26 PM
N4	50	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth object) WITH dimensions).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:26 PM
N5	16	(tim$4 SAME (var$4 chang$4 modif$4 alter$4) SAME (illuminat$4 light$4) SAME pattern SAME (teeth tooth) SAME dimensions)	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:27 PM
N6	13	(tim$4 near50 (var$4 chang$4 modif$4 alter$4) near50 (illuminat$4 light$4) near50 pattern near50 (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:28 PM
N7	22	(tim$4 WITH (var$4 chang$4 modif$4 alter$4) WITH (illuminat$4 light$4) WITH pattern WITH (teeth tooth))	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:28 PM
N8	72	(hollenbeck-karl-josef).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:29 PM
N9	20	(qazi-arish-a).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:29 PM
N10	62	(van-der-poel-mike).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:30 PM
N11	10	(kjaer-rasmus).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02

							01:31 PM
N12	59	(ojelund-henrik).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:31 PM
N13	201	(fisker-rune).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/02/02 01:32 PM

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	17533403
Filing Date	23-Nov-2021
First Named Inventor	Rune FISKER
Attorney Docket Number	0079124-000370-T1
Title of Invention	FOCUS SCANNING APPARATUS

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
3Shape A/S	100%

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

10595010

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.	
Applicant claims the following fee status: ○ Small Entity ○ Micro Entity ◉ Regular Undiscounted 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 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.	
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: ◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application Registration Number 30888 ○ A sole inventor ○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ○ A joint inventor; all of whom are signing this request	
Signature	/WCRowland/
Name	William C Rowland

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	17533403
Filing Date:	23-Nov-2021
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Filer:	William C. Rowland
Attorney Docket Number:	0079124-000370-T1

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	1814	1	170	170
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**170**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 17533403

Filing Date: 23-Nov-2021

Applicant/Patent under Reexamination: FISKER

Electronic Terminal Disclaimer filed on February 22, 2022

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt

EFS ID:	45055787
Application Number:	17533403
International Application Number:	
Confirmation Number:	9694
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Customer Number:	21839
Filer:	William C. Rowland
Filer Authorized By:	
Attorney Docket Number:	0079124-000370-T1
Receipt Date:	22-FEB-2022
Filing Date:	23-NOV-2021
Time Stamp:	16:31:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$170
RAM confirmation Number	E20222LG31474111
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	41271 069e639cc730d62ceb1111fe1f5d395287991b1b	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37853 3d16f0cd665a4ba3e229f46b78a40ecef7b29e12	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	79124		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 17/533,403	Filing Date 11/23/2021	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $480 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	02/21/2022	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 31	Minus	** 30	= 1		x $100 =	100
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	100

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LDRC
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/EVA V GILLIS/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	
	)	
Rune FISKER	)	Group Art Unit: 2484
	)	
Application No.: 17/533,403	)	Examiner: Jose M. Mesa
	)	
Filed: November 23, 2021	)	Confirmation No.: 9694
	)	
For: FOCUS SCANNING APPARATUS	)	
	)	
	)	
	)	

SUPPLEMENTAL PRELIMINARY AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

Prior to examination of the above-captioned patent application and subsequent to the Preliminary Amendment filed on November 23, 2021, please amend the application as follows:

AMENDMENTS TO THE CLAIMS:

The following listing of claims will replace all prior versions and listings of claims in this application.

LISTING OF CLAIMS:

1. (Cancelled)

2. (Currently Amended) **[[**An**]]** A handheld intraoral scanner for determining the 3D geometry and color of at least a part of the surface of an object in an oral cavity, the intraoral scanner comprising:

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

- a hardware processor, located within the wireless intraoral scanner, configured to:
    - selectively switch a color of the probe light to illuminate the object with different colors at different times; and
    - record images of the object with the different colors by recording different images by the at least one camera at the different times.

3. (Currently Amended) The handheld intraoral scanner according to claim 2, wherein the light source further comprises ~~different colors are provided by~~ at least three monochromatic light sources configured to provide the different colors ~~of the light source~~.

4. (Currently Amended) The handheld intraoral scanner according to claim 3, wherein for the selectively switch the color of the probe light, the hardware processor is further configured to selectively switch the color of the probe light by switching on and off the at least three monochromatic light sources.

5. (Currently Amended) The handheld intraoral scanner according to claim 2, wherein the optical system is substantially achromatic.

6. (Currently Amended) The handheld intraoral scanner according to claim 2, wherein the optical system is configured to direct the probe light ~~is directed~~ towards the object in a direction substantially parallel with the longitudinal axis of the tip, and wherein the tip further comprises a single reflective mirror that is configured to reflect the probe light ~~is further reflected~~ towards the object ~~by a single reflective mirror located in the tip~~.

7. (Currently Amended) The handheld intraoral scanner according to claim 2, wherein the hardware processor is further configured to:

process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and

transmit, via a wireless connection, the processed data for the 3D geometry.

8. (Currently Amended) The handheld intraoral scanner according to claim 2, wherein the hardware processor is further configured to:

process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and

transmit, via a wireless connection, the data for the 3D geometry at a reduced data rate in comparison with transmission of the raw 3D data.

9. (Currently Amended) The handheld intraoral scanner according to claim 7, wherein the hardware processor ~~processes~~ is further configured to process the raw 3D data into data for the 3D geometry in real time.

10. (Currently Amended) The handheld intraoral scanner according to claim 2, wherein the ~~intraoral scanner~~ light source comprises at least two light sources~~, each of the light sources~~ configured to operate with the pattern generator.

11. (Currently Amended) The handheld intraoral scanner according to claim 10, wherein the at least two light sources are configured to operate with different wavelengths.

12. (Currently Amended) The handheld intraoral scanner according to claim 11, wherein the intraoral oral scanner is configured such that the different wavelengths can be ~~manually~~ selected, whereby the 3D geometry is dependent on which of the at least two light ~~source~~ sources is being ~~manually~~ selected.

13. (Currently Amended) The handheld intraoral scanner according to claim 2, wherein the hardware processor is further configured to:

output data from the one or more motion sensors for remotely controlling an image displayed on a display device based on acquired scan data.

14. (Currently Amended) The handheld intraoral scanner according to claim 2, wherein the hardware processor is further configured to:

output data from the one or more motion sensors for stitching and/or registering partial scans to one another.

15. (Currently Amended) **[[**An**]]** A handheld intraoral scanner for determining the 3D geometry and color of at least a part of the surface of an object in an oral cavity, the intraoral scanner comprising:

- a tip configured to be inserted into the oral cavity;
- at least one camera accommodating an array of sensor elements;
- a pattern generator configured to generate, using a light source, a probe light with a plurality of configurations in the form of a time-varying illumination pattern;

- an optical system ~~for transmitting~~ configured to transmit the probe light, via the tip, towards the object along an optical path thereby illuminating at least a part of the object with the time-varying illumination pattern, and ~~for transmitting~~ to transmit at least a part of the light returned from the object to the at least one camera to form a plurality of 2D images, wherein the 3D geometry is determined based on the plurality of 2D images and the time-varying illumination pattern, wherein the intraoral scanner is wireless; and
- a hardware processor, located within the wireless intraoral scanner, configured to:
    - selectively switch a color of the probe light to illuminate the object with different colors at different times;
    - record images of the object with the different colors by recording different images by the at least one camera at the different times;
    - process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and
    - transmit, via a wireless connection, the data for the 3D geometry at a reduced data rate in comparison with transmission of the raw 3D data.

16. (Currently Amended) The handheld intraoral scanner of claim 15, wherein the hardware processor ~~processes~~ is further configured to process the raw 3D data into data for the 3D geometry in real time.

17. (Currently Amended) The handheld intraoral scanner of claim 15, further comprising:

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

18. (Currently Amended) The handheld intraoral scanner according to claim 17 wherein the hardware processor is further configured to:

output data from the one or more motion sensors for remotely controlling an image displayed on a display device based on acquired scan data.

19. (Currently Amended) The handheld intraoral scanner according to claim 17, wherein the hardware processor is further configured to:

output data from the one or more motion sensors for stitching and/or registering partial scans to one another.

20. (Currently Amended) The handheld intraoral scanner according to claim 15, wherein the light source further comprises ~~different colors are provided by~~ at least three monochromatic light sources ~~of the light source~~ configured to provide the different colors.

21. (Cancelled)

22. (Currently Amended) The handheld intraoral scanner according to claim 21, wherein the hardware processor is further configured to selectively switch the color of the probe light by switching on and off the at least three monochromatic light sources.

23. (Currently Amended) The handheld intraoral scanner according to claim 15, wherein the optical system is substantially achromatic.

24. (Currently Amended) The handheld intraoral scanner according to claim 15, wherein the optical system is further configured to direct the probe light ~~is directed~~ towards the object in a direction substantially parallel with the longitudinal axis of the tip, and wherein the tip further comprises a single reflective mirror that is configured to reflect the probe light ~~is further reflected~~ towards the object ~~by a single reflective mirror located in the tip~~.

25. (Currently Amended) The handheld intraoral scanner according to claim 15, wherein the ~~intraoral scanner~~ light source further comprises at least two light sources~~, each of the light sources~~ configured to operate with the pattern generator.

26. (Currently Amended) The handheld intraoral scanner according to claim 25, wherein the at least two light sources are configured to operate with different wavelengths.

27. (Currently Amended) The handheld intraoral scanner according to claim 26, wherein the intraoral oral scanner is configured such that the different wavelengths can be ~~manually~~ selected, whereby the 3D geometry is dependent on which of the at least two light ~~source~~ sources is being ~~manually~~ selected.

28. (Currently Amended) **[[**An**]]** A handheld intraoral scanner for determining the 3D geometry and color of at least a part of the surface of an object in an oral cavity, the intraoral scanner comprising:

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

29. (Currently Amended) The handheld intraoral scanner according to claim 28, wherein the hardware processor is further configured to:

output data from the one or more motion sensors for remotely controlling an image displayed on a display device based on acquired scan data.

30. (Currently Amended) The handheld intraoral scanner according to claim 28, wherein the hardware processor is further configured to:

output data from the one or more motion sensors for stitching and/or registering partial scans to one another.

31. (Currently Amended) The handheld intraoral scanner according to claim 28, wherein the intraoral scanner is wireless and the hardware processor is further configured to:

process raw 3D data into data for the 3D geometry, wherein the raw 3D data is based on the plurality of 2D images; and

transmit, via a wireless connection, the data for the 3D geometry at a reduced data rate in comparison with transmission of the raw 3D data.

32. (New) The handheld intraoral scanner according to claim 12, wherein the intraoral oral scanner is configured such that the different wavelengths can be manually selected, whereby the 3D geometry is dependent on which of the at least two light sources is being manually selected.

33. (New) The handheld intraoral scanner according to claim 26, wherein the intraoral oral scanner is configured such that the different wavelengths can be manually selected, whereby the 3D geometry is dependent on which of the at least two light sources is being manually selected.

REMARKS

By way of the foregoing amendment, the claims are amended for clarity. No new issues are raised by the amendments.

It is requested that the application be examined on the basis of the amendments presented herein. Early and favorable consideration of this application is respectfully requested.

Should any questions arise in connection with this application, it is respectfully requested that the undersigned be contacted at the number indicated below.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date February 21, 2022

By: /WCRowland/
William C. Rowland
Registration No. 30,888

Customer No. 21839
703 836 6620

Electronic Patent Application Fee Transmittal

Application Number:	17533403
Filing Date:	23-Nov-2021
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Filer:	William C. Rowland/Stacey Pflieger
Attorney Docket Number:	0079124-000370-T1

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	1	100	100
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**100**

Electronic Acknowledgement Receipt

EFS ID:	45043216
Application Number:	17533403
International Application Number:	
Confirmation Number:	9694
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Customer Number:	21839
Filer:	William C. Rowland/Stacey Pflieger
Filer Authorized By:	William C. Rowland
Attorney Docket Number:	0079124-000370-T1
Receipt Date:	21-FEB-2022
Filing Date:	23-NOV-2021
Time Stamp:	12:27:27
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$100
RAM confirmation Number	E20222KC27523816
Deposit Account	024800
Authorized User	Stacey Pflieger

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37 CFR 1.16 (National application filing, search, and examination fees)

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1		370preamd.pdf	120418 9e63fe948d0f6df3168178719ade4b03a8c1a7ef	yes	11

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Preliminary Amendment	1	1
Claims	2	10
Applicant Arguments/Remarks Made in an Amendment	11	11

Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37779 ee2bc0eb708461f84744ab8376249507977 10019	no	2
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER et al.
Art Unit	2484
Examiner Name	Jose M. MESA
Attorney Docket Number	0079124-000370-T1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4781448		1988-01-01	Chatenenver et al.	
	2	5605459	A	1997-02-25	Kuroda et al.	
	3	5675407	A	1997-10-07	Geng	
	4	5702249	A	1997-12-30	Cooper	
	5	7077647	B2	2006-07-18	Choi et al.	
	6	7230771	B2	2007-06-12	Kuiper et al.	
	7	8571397	B2	2013-10-29	Liu et al.	
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	1	20050237581	A1	2005-10-27	Knighton et al.	
	2	20060092133	A1	2006-05-04	Touma et al.	
	3	20060212260	A1	2006-09-21	Kopelman et al.	
	4	20070172112	A1	2007-07-26	Paley et al.	
	5	20100009308	A1	2010-01-14	Wen et al.	

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	1	3321866	JP	B2	2002-09-09	Hitachi Ltd.	(with English Translation)	X

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	Application Number	17533403
	Filing Date	2021-11-23
	First Named Inventor	Rune FISKER et al.
	Art Unit	2484
	Examiner Name	Jose M. MESA
	Attorney Docket Number	0079124-000370-T1

	1	Declaration of Lambertus Hesselink, Ph.D., Exhibit 1002.	
	2	Order, Lipocine Inc. v. Clarus Therapeutics, Inc., Case No. 1:19-cv-00622-WCB (November 12, 2020), Exhibit 1052.	
	3	Defendant Align Technology, Inc.'s Stipulation of Invalidity Contentions, 3Shape A/S v. Align Technology, Inc., Case No. 1:18-cv-00886-LPS (November 13, 2020), Exhibit 1053.	
	4	Transcript of July 16, 2021 Deposition of Alexander V. Sergienko, Ph.D., Exhibit 1056.	
	5	Reply Declaration of Lambertus Hesselink, Exhibit 1057.	
	6	Declaration of Alexander Sergienko, Ph.D. in 3Shape A/S et al. v. Align Technology, Inc., Case No. IPR2020-01622, Exhibit 1061.	
	7	Patent Owner's Preliminary Response to the Petition for Inter Partes Review of U.S. Patent No. 10,349,042, Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01088 (October 23, 2020), Exhibit 1062.	
	8	Petition for Inter Partes Review of U.S. Patent No. 8,363,228, 3Shape A/S et al. v. Align Technology, Inc., Case No. IPR2019-00157 (November 8, 2018), Exhibit 1063.	
	9	C.S. FRASER et al., "Zoom-Dependent Camera Calibration in Digital Close-Range Photogrammetry", Photogrammetric Engineering & Remote Sensing 72(9): 1017-1026 (September 2006), Exhibit 1064.	
	10	W.J. SMITH, "Modern Optical Engineering: The Design of Optical Systems", Third Edition, 2000, Exhibit 1065.	
	11	Declaration of Alexander Sergienko, Ph.D., Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01087, Exhibit 2019.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17533403
	Filing Date	2021-11-23
	First Named Inventor	Rune FISKER et al.
	Art Unit	2484
	Examiner Name	Jose M. MESA
	Attorney Docket Number	0079124-000370-T1

	12	Memorandum Order, C.A. No. 18-886-LPS (D. Del), December 28, 2020, Exhibit 2022.
	13	Deposition Transcript of Dr. Lambertus Hesselink taken April 2, 2021, Exhibit 2023.
	14	Reg G. Willson and Steven A. Shafer, "Dynamic Lens Compensation for Active Color Imaging and Constant Magnification Focusing", The Robotics Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213, November 1991 ("Willson"), Exhibit 2027.
	15	Trevor Darrell and Kwangyoen Wohn, "Pyramid Based Depth from Focus", Grasp Laboratory, Computer and Information Science, Univ. of Pennsylvania, Proceedings of Computer Vision and Pattern Recognition, Ann Arbor, Michigan, June 1988, Computer Society, IEEE Computer Society, pp. 504-509. ("Darrell"), Exhibit 2028.
	16	Declaration of Sylvia Hall-Ellis, Ph.D. with attachments, Align Technology, Inc. v. 3Shape A/S, Case No. IPR2020-01087, Exhibit 2029.
	17	Deposition Transcript of Dr. Lambertus Hesselink taken September 10, 2021, Exhibit 2030.
	18	Final Written Decision, Align Technology, Inc. v. 3Shape A/S, IPR2020-01087, January 19, 2022.

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Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER et al.
Art Unit	2484
Examiner Name	Jose M. MESA
Attorney Docket Number	0079124-000370-T1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

✓ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/WCRowland/	Date (YYYY-MM-DD)	2022-02-02
Name/Print	William C. Rowland	Registration Number	30,888

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TRANSPERFECT

City of New York, State of New York, County of New York

I, Artem Furman, hereby certify that the document "**JP3321866B2**" is to the best of my knowledge and belief, a true and accurate translation from Japanese into English.

Artem Furman

Sworn to before me this
February 4, 2020

Signature, Notary Public

WENDY POON
NOTARY
NO. 01PO6386784
QUALIFIED IN
QUEENS COUNTY
COMM. EXP.
04-02-2021
PUBLIC
STATE OF NEW YORK

Stamp, Notary Public

(19) Japan Patent Office (JP)

(12) Patent Gazette (B2)

(11) Patent Number

Japanese Patent No. 3321866
(P3321866)

(45) Publication date: September 9, 2002 (9/9/2002)

(24) Registration date: June 28, 2002 (6/28/2002)

(51) Int. Cl.[7]	Identification numbers	FI		
G01B 11/24		G01B	11/24	K

Number of claims: 6 (Total of 19 pages)

(21) Application number	Japanese Patent Application H4--347686
(22) Filing date	December 28, 1992 (12/28/1992)
(65) Japanese unexamined patent application publication number	Japanese Unexamined Patent Application Publication H6--201337
(43) Japanese unexamined patent application publication date	July 19, 1994 (7/19/1994)
Examination request date	March 26, 1999 (3/26/1999)

(73) Patentee	000005108 Hitachi, Ltd. 6 Kanda Surugadai 4-chome, Chiyoda-ku, Tokyo-to
(72) Inventor	NOGUCHI, Minoru c/o Hitachi Ltd. Production Engineering Research Laboratory, 292 Yoshida-cho, Totsuka-ku, Yokohama-shi, Kanagawa-ken
(72) Inventor	NAKAGAWA, Yasuo c/o Hitachi Ltd. Production Engineering Research Laboratory, 292 Yoshida-cho, Totsuka-ku, Yokohama-shi, Kanagawa-ken
(74) Agent	100075096 Patent attorney SAKUTA, Yasuo
Examiner	YAMASHITA, Masato
(56) References	Japanese Unexamined Patent Application Publication H6--201349 (JP, A) Japanese Unexamined Patent Application Publication H3--63507 (JP, A)

Continued on last page

(54) [Title of the invention] Surface shape detection device and method

(57) [Scope of patent claims]

[Claim 1] A surface shape detection device characterized in that it comprises: an illumination means which projects a texture pattern onto an object; a detection means which detects the texture pattern projected by said illumination means and converts it to an image signal using a photoelectric conversion means; a focal point position control means which provides control so as to change the focal point position; and a three-dimensional shape computation means which detects and stores multiple texture pattern image signals using said detection means while changing the focal point position using said focal point position control means, and processes the stored multiple texture pattern image signals by correcting for deformation due to effects of the surface of said object so as to thereby compute its three-dimensional shape.

[Claim 2] A surface shape detection device as set forth in claim 1, characterized in that the correction for deformation due to effects of the surface of the object is correction for movement of the detection position due to reflection and surface lens effects.

[Claim 3] A surface shape detection device as set forth in claim 1, characterized in that it comprises, as said three-dimensional shape computation means, a contrast computation means which uses a differential operator and dynamically changes the operator size to compute contrast of multiple texture pattern image signals.

[Claim 4] A surface shape detection device as set forth in claim 1, characterized in that said illumination means has an optical system with a large numerical aperture (N.A.) and is configured to project a texture pattern of small focal depth; said detection means comprises an optical system with a large numerical aperture configured such that the focal point aligns at the position of the texture pattern projected by said illumination means; and said focal point position control means is configured so as to change the focal point position such that the focal point position of the optical system of said illumination means overlaps the focal point position of the optical system of the

detection means.

[Claim 5] A surface shape detection device as set forth in claim 1, characterized in that the photoelectric conversion means of said detection means is formed by connecting the electrodes of multiple adjacent elements such that their electric charges cancel each other out.

[Claim 6] A surface shape detection method characterized in that a texture pattern is projected by illumination onto an object; the projected texture pattern is detected while controlling and changing the focal point position and is converted into and detected as multiple texture pattern image signals using a photoelectric conversion means; and the detected multiple texture pattern image signals are processing by correcting for deformation due to effects of the surface of said object so as to thereby compute its three-dimensional shape.

[Detailed description of the invention]

[0001]

[Field of industrial application] The present invention relates to a surface shape detection device and method for detecting the surface shape of an object having a three-dimensional shape based on detected image signals for recognition of external appearance and shape during production of industrial products or movement of physical objects, or for conducting inspection based on the results of such recognition.

[0002]

[Prior art] Numerous methods of reproducing a three-dimensional shape based on detected images have been previously reported. Japanese Unexamined Patent Application Publication H3--63507 discloses a method wherein a texture pattern is projected onto an object, multiple images with different focal point positions are detected while changing the focal point position, and the surface shape of the object is determined based on change in contrast of the detected images.

[0003] Furthermore, in "Functional level imitation of motion parallax in artificial vision" by Ogasawara (Denshi Joho Tsushin Gakkai Ronbunshi, D-II Vol. J74-D-II No. 7, pp. 933--944), there is disclosed a three-dimensional shape detection method based on movement of viewpoint.

[0004] Furthermore, in Adiv G.: "Determining three-dimensional motion and structure from optical flow generated by several moving objects", IEEE Trans. Pattern Anal. & Mach. Intell., PAMI-7, 4, pp. 384--401 (1985), a method using optical flow is proposed.

[0005]

[Problem to be solved by the invention] However, while Japanese Unexamined Patent Application Publication H3--63507 allows one to rapidly detect the three-dimensional shape of any object based on multiple images with different focal point positions, it does not allow one to detect the three-dimensional shape of objects having a smooth diffuse surface or mirror surface with no texture on the surface, objects with a low contrast surface texture, objects of large depth extent, or objects having a surface with changing surface texture shape or contrast.

[0006] Furthermore, according to "Functional level imitation of motion parallax in artificial vision" by Ogasawara (Denshi Joho Tsushin Gakkai Ronbunshi, D-II Vol. J74-D-II No. 7, pp. 933--944), while it is possible to detect the three-dimensional shape of objects with emphasized edges, it is not possible to detect three-dimensional shapes of objects having a smooth diffuse surface or mirror surface with no texture on the surface, objects with low surface texture contrast, or objects having a surface with changing surface texture shape or contrast. Furthermore, while it is possible to detect the three-dimensional shape of objects with emphasized edges, time-consuming computational processing for edge tracking, etc. becomes necessary, and furthermore, advanced computation processing susceptible to noise, such as classification and segmentation, becomes necessary.

[0007] Moreover, for methods using optical flow, differential continuity is an essential condition, so with methods using a TV camera, etc., there is the problem that differential continuity cannot be maintained at steep edges, making it impossible to detect the three-dimensional shape.

[0008] It is an object of the present invention to resolve these problems and provide a surface shape detection device and method which make it possible to rapidly detect the surface shape and three-dimensional shape of objects having a smooth diffuse surface or mirror surface with no texture on the surface, objects with low surface texture contrast, or objects having a surface with changing surface texture shape or contrast.

[0009]

[Means for solving the problem] To achieve the aforesaid object, the present invention is a surface shape detection device and method characterized in that it comprises an illumination means which projects a texture pattern onto an object; a detection means which detects the texture pattern projected by said illumination means and converts it to an image signal using a photoelectric conversion means; a focal point position control means which provides control so as to change the focal point position; and a three-dimensional shape computation means which detects and stores multiple texture pattern image signals using said detection means while changing the focal point position using said focal point position control means, and processes the stored multiple texture pattern image signals by correcting for deformation due to effects of the surface of said object so as to thereby compute its three-dimensional shape. Namely, in order to detect the surface shape of objects having a smooth diffuse surface or mirror surface with no texture on the surface, objects with low surface texture contrast, or objects having a surface with changing surface texture shape or contrast, the present invention comprises an illumination means which projects a texture pattern onto an object; a detection means which receives the texture pattern projected by said illumination means using a photoelectric conversion means and detects it as an image signal; a focal point position changing means which changes the focal point position while a texture pattern is being projected by said illumination means or is being detected by said detection means; and a computation means which detects and stores multiple images using said detection means while changing the focal point position using said focal point position changing means, and processes the stored image signals by correcting for deformation due to effects of the surface of said object so as to thereby compute its three-dimensional shape.

[0010] More specifically, in the present invention, shape detection of objects having a mirror surface without texture on the surface is accomplished in that a texture pattern is projected to the vicinity of the surface and is detected as multiple images while changing the focal point, and correction is performed for

variation of the detection position due to reflection and surface lens effects.

[0011] Furthermore, in the present invention, shape detection of objects having a smooth diffuse surface without texture on the surface or objects with a low surface texture contrast is accomplished in that a texture pattern with a large focal depth is projected using an illumination optical system comprising an optical system with a small numerical aperture (N.A.), multiple images with different focal point position are detected using a detection optical system comprising an optical system with a large numerical aperture, and contrast change is computed based on the detected images to compute the surface shape; or else, a texture pattern with a small focal depth is projected by means of an illumination optical system comprising an optical system with a large numerical aperture while changing the focal point position during projection, images are detected with a detection optical system comprising an optical system with a small numerical aperture, and contrast change is computed based on the detected images to compute the surface shape; or else, a texture pattern with a small focal depth is projected by means of an illumination optical system comprising an optical system with a large numerical aperture while changing the focal point position during projection, images are detected while simultaneously changing the focal point position of a detection optical system comprising an optical system with a large numerical aperture in synchronized fashion so as to make it the same as the focal point position of the illumination optical system, and contrast changes are computed based on the detected images to compute the surface shape.

[0012] Furthermore, in the present invention, shape detection of objects having a surface with a changing surface texture shape (pitch or contrast) or changing contrast is accomplished by means of computation processing which maximizes S/N during contrast computation by dynamically changing the size of the differential operator used during contrast computation. Alternatively, this is accomplished by projecting a texture pattern with a projection optical system having a large numerical aperture so as to make the contrast during detection and computation sufficiently high.

[0013] Furthermore, in the present invention, for shape detection of objects having a surface with changing surface texture shape (pitch or contrast) or changing contrast, grayscale images detected without using the concept of contrast are differentiated in the planar direction, and the focal point position at which the derivative achieves its maximum value at each identical coordinate position of the images obtained by differentiation is computed to compute the shape.

[0014] Furthermore, for shape detection of objects having a surface with changing surface texture shape or contrast, the present invention is characterized in that it comprises: an optical system which forms an image of an object on a detector; a means which detects the formed image with a detector having an optical resolution higher than the image forming resolution of the optical system; a means which changes the position or direction for detecting the image during image detection (moves the position of the viewpoint); and a computation means which controls sampling time such that the time until the next sampling (sampling time for computation of spatial rate of change) will be sufficiently long to ensure a sufficient amount of spatial movement during such time for the spatial rate of change to become sufficiently large, but such that sampling time will be sufficiently short so that the spatial rate of change does not become infinite for steep portions such as edges, in other words, sufficiently short to allow computation, and changes the aforementioned conditions in order to compute the spatial rate of change and temporal rate of change of light intensity based on image signals obtained from the detector, and then computes velocity, which is the change of detection position in relation to movement of the viewpoint, based on the computed spatial rate of change and temporal rate of change, and computes the surface shape of the object based on the computed velocity.

[0015] Furthermore, in the present invention, detection of two-dimensional images of an object is accomplished by increasing the contrast of the detector.

[0016]

[Function] In order to detect the surface shape of objects having a smooth diffuse surface or mirror surface with no texture on the surface, objects with low surface texture contrast, or objects having a surface with changing surface texture shape or contrast, there is provided a means which projects a texture pattern onto an object, a means which detects the projected texture pattern, a means which changes the focal point position when projecting or detecting the texture pattern, a means which detects and stores multiple images while changing the focal point position, and a means which computes the three-dimensional shape of the target by processing the detected and stored signals.

[0017] The function of the shape detection method for objects having a mirror surface with no texture on the surface will be described.

[0018] A method of detecting focal point position on mirror surface-like flat surfaces having no texture on the surface is disclosed in Japanese Unexamined Patent Application Publication S61–124809. This method involves projecting a pattern onto the flat surface and detecting the focal point position based on the resulting contrast change, but shape detection of mirror surfaces having an arbitrary three-dimensional shape is not possible with this method. However, it was noted that the idea of projecting a pattern onto mirror surface-like surfaces can be made use of for solving this problem. Namely, for determining the shape of an object having a mirror surface without texture on the surface, if a texture pattern is projected to the vicinity of the surface and is detected as multiple images while changing the focal point, it becomes possible to detect contrast change. Furthermore, based on contrast computed in this manner, it is possible to compute some sort of shape by the method disclosed in Japanese Unexamined Patent Application Publication H3–63507, but it must be borne in mind that shapes computed in this manner will contain variation of the detection position due to reflection and surface lens effects. The correction method for this will be described.

[0019] When a texture pattern is projected onto an object having a mirror surface with no texture on the surface, the texture pattern is reflected from the object and is observed as being at a symmetrical position of the object. It is furthermore observed as being at a position converted due to lens effects of concavoconvex structures of the surface of the object. Therefore, when one determines the shape of the object surface by detecting images while changing the focal point position, a shape different from the actual shape will be determined. Thus, to find out the true shape, it is necessary to correct for the

deformation due to the effects of such reflection and the lens effects. Assuming that the shape deformed due to reflection effects and lens effects, i.e. the detected shape, is $\Delta z(x, y)$, the

$$1/a\ (\Delta z(x, y), a0) + 1/b = 1/f\ (F, R(x, y)) \quad \text{(mathematical formula 1)}$$

$$R(x, y) = k \cdot \text{grad}(\Delta z0(x, y)) \quad \text{(mathematical formula 2)}$$

Here, the distance $a(\Delta z(x,y), a0)$ from the primary principal plane of the detection optical system to the object is to be corrected based on the lens effects of the true shape $\Delta z0(x, y)$, and is thus a function of the distance a0 from the primary principal plane to the object in the case of a true shape $\Delta z0(x, y)$ and no lens effect.

[0021] On the basis of the detected shape $\Delta z(x, y)$, by correcting using the above formulas (mathematical formula 1) and (mathematical formula 2), it is possible to determine (compute) the true shape $\Delta z0(x, y)$.

[0022] The function of the shape detection method for objects having a smooth diffuse surface with no texture on the surface will be described. With such objects, it is necessary to project a texture onto the surface. A method of projecting a texture pattern onto the surface is disclosed in Japanese Unexamined Patent Application Publication H3-63507, but the focal depth and image resolution of the optical system are not mentioned.

$$d = 1.22 \cdot \lambda/N.A.$$

Furthermore, the focal depth $\pm h$ is represented by the following formula (mathematical formula 4)

$$h = 0.5 \cdot \lambda/(N.A.)^2$$

FIG. 10 shows the numerical aperture N.A. of an optical system and the focal depth h and optical resolution (image resolution) d corresponding to the numerical aperture N.A., computed with the above formulas (mathematical formula 3) and (mathematical formula 4). The results shown in FIG. 10 have been computed for a wavelength of 0.5 microns.

[0025] Based on this FIG. 10, for example, if the numerical aperture N.A. of the illumination optical system is near 0.008, the optical resolution d will be about 76 microns and the focal depth $\pm h$ will be about 3.9 mm. Here, if the numerical aperture N.A. of the detection optical system is about 0.04, the focal depth $\pm h$ will be about 156 microns and the optical resolution d in the planar direction during detection will be about 10 microns. Here, Japanese Unexamined Patent Application Publication H3-63507 discloses a configuration in which the focal depth $\pm h$ of the detection system is changed, but in particular in the case of objects having a smooth diffuse surface, it can be seen that one can also reduce the focal depth $\pm h$ of the illumination system and change the focal position of the illumination system. Namely, the numerical aperture N.A. of the illumination system is made about 0.03 and a texture pattern of about 100 microns is projected. Since the optical resolution d of the illumination system is about 20 microns, the texture pattern will be projected at a high image resolution. Here, if the numerical aperture N.A. of the detection optical system is made about 0.006, the optical resolution d will be about 100 microns, and it will be possible to ensure a focal depth $\pm h$ of 7 mm. Therefore, it will be possible to detect the three-dimensional shape of objects having a smooth diffuse surface.

[0026] Moreover, for example, when an object not having surface texture of about 1 mm in the height direction is detected with a planar optical resolution of about 10 microns, it can be seen from FIG. 10 that there is no suitable projection optical system or detection optical system. In such cases, the numerical aperture N.A. of the illumination optical system and detection optical system are both made about 0.1 to secure an optical resolution d of 6 microns. Furthermore, it is possible to detect multiple images while synchronizing the focal point position of the illumination optical system and the focal point position of the detection optical system, and detect the planar shape based on contrast change. With such a configuration, it is possible to detect the three-dimensional shape for objects which are taller in the height direction than the focal depth of the optical system. Furthermore, to detect the shape of objects with a mirror surface, it is necessary to make the focal depth of the illumination optical system shallower, so this sort of configuration in which the focal points of the detection optical system and illumination optical system are synchronized is effective.

[0027] The function of the shape detection method for objects having a surface with a changing surface texture shape (pitch or contrast) or changing contrast will be described. During contrast computation, especially in cases where the light intensity change due to surface texture is slow, if the contrast is computed in the range of slow change, it may be realistically impossible to compute the contrast due to increase in noise through differentiation. Here, contrast can be computed at high accuracy by dynamically changing the size of the differential operator so that the contrast value becomes sufficiently large, or through computational processing using an operator which maximizes the S/N during computation. Alternatively, the contrast can be computed with high accuracy based on the same function as that of the detection method for objects having a diffuse surface, by projecting an appropriate texture as in the case of objects having a smooth diffuse surface.

[0028] Furthermore, in the case of objects having a texture such that the contrast changes in the planar direction, or when the contrast of the projected texture changes, with the method of Japanese Unexamined Patent Application Publication H3-65307,

[0020] true shape $\Delta z0(x, y)$ is represented by the following formulas (mathematical formula 1) and (mathematical formula 2).

[0023] However, when projecting the texture pattern, it is necessary to take into consideration the focal depth and image resolution of the optical system. In cases where the surface is a smooth diffuse surface and the shape is deep in the height direction, in order to project a texture pattern onto such an object, an optical system with a large focal depth is necessary. However, the optical system with a large focal depth needs to have a small numerical aperture, and optical systems with a small numerical aperture have 4low image resolution and cannot project a fine texture pattern. Namely, it is not possible to implement an optical system having adequate image resolution in the planar direction during texture pattern detection and a large focal depth in the optical axis direction. The image resolution d is represented by the following formula (mathematical formula 3), where N.A. is numerical aperture and λ is the wavelength used.

[0024] (mathematical formula 3)

(mathematical formula 4)

if the size of the differential operator for computing the contrast is not set to an appropriate value, the contrast cannot be computed. However, with the configuration of the present invention, the maximum value of the derivative is computed from the change in derivative computed for each focal point position at each coordinate position, thus making it possible to compute the three-dimensional shape of objects with a contrast that changes in plane and objects for which the period of the texture pattern changes.

[0029] Furthermore, shape detection for objects having a surface with a changing surface texture shape or contrast is solved by means of an optical system which forms an image of an object on a detector; a means which detects the formed image with a detector having an optical resolution higher than the image forming resolution of the optical system; a means which changes the position or direction for detecting the image during image detection; a means which computes the spatial rate of change and temporal rate of change of light intensity based on images acquired by changing the aforementioned conditions; a means which controls sampling time for computation of the spatial rate of change and temporal rate of change such that the time until the next sampling (sampling time for computation of spatial rate of change) will be sufficiently long to ensure a sufficient amount of spatial movement during such time for the spatial rate of change to become sufficiently large, but such that sampling time will be sufficiently short so that the spatial rate of change does not become infinite for steep portions such as edges, in other words, sufficiently short to allow computation; and a means which computes angular velocity based on the spatial rate of change and temporal rate of change.

[0030] In Japanese Unexamined Patent Application Publication H3-63507, wherein change in contrast is computed while changing the focal point position, in the case of objects with a spatial period of the texture pattern that is sufficiently greater than the optical resolution of the detection optical system, the contrast will not change by changing the focal point position, so it is difficult to the detect contrast change. By contrast, with the above-described configuration of the present invention, change in contrast is computed while changing the position of the detector, so contrast change can be acquired.

[0031] Furthermore, for detecting two-dimensional images of objects, the aforementioned problem can be resolved by increasing the contrast of the detector.

[0032]

[Embodiment examples] FIG. 11 illustrates an embodiment example of the present invention. The present invention comprises an illumination optical system 400 comprising a light source 401, diffusion plate 402, texture pattern 403 and half-mirror 404; a detection optical system 500 comprising a detection lens 501 and detector 502; and a signal processing system 500 comprising a differentiator circuit 501, frame memories 502, 503, 504, peak detection circuit 505 and frame memory 506.

[0033] In the illumination optical system 400, the texture pattern 403 is illuminated with the light source 401 and is imaged via the half-mirror 404 and detection lens 501 in the vicinity 4 of the object 1. In the detection optical system 500, an image of the texture pattern 403 that has been formed in the vicinity 4 is formed on the detector 502 by means of the detection lens 501.

[0034] For example, multiple images (light intensities) detected for object 7 shown in FIG. 12 while changing the focal point position from 13 to 14 to 15 are shown respectively under 8, 9 and 10 in FIG. 13. The detected image signals are differentiated by means of differentiator circuit 601, and contrast is computed as indicated under 16, 17 and 18 in FIG. 14. These differentiation results, i.e. contrasts, are loaded into and stored in frame memories 602, 603, 604. The focal point position at which the derivative value is at maximum for each coordinate position is computed using the computation means 605 based on the images which have been loaded into and stored in frame memories 602, 603, 604. An example for coordinate position 19 will be presented. The contrast of each image at this coordinate position 19 is 20, 21 and 22 respectively. These contrasts 20, 21, 22 are shown in FIG. 15, where the horizontal axis is the focal point position. This FIG. 15 is interpolated to compute the contrast maximum using the computation means 605. For computation of this maximum, Japanese Unexamined Patent Application Publication H3-63507 discloses a method of computing the maximum by assuming a Gaussian distribution, but a Gaussian distribution need not necessarily be assumed, and quadratic curve approximation is also possible. In this case, the maximum value of contrast is computed by interpolation with a quadratic curve, as shown in FIG. 15. Here, it is preferable for the computation result to be ultimately computed through interpolation. Furthermore, there is essentially no problem with computing as in FIG. 15, and there is also the advantage that the computation processing is easy.

[0035] The results computed for focal point position, i.e. height information of the object, are stored in frame memory 606.

[0036] Maximum values which have been computed by the computation means 605 as described above are stored in frame memory 606 and become the three-dimensional shape of the object surface formed from the focal point positions, i.e. the height information for the object. Here, if no maximum value exists, it means there was no location at which the focal point was in focus within this range and so the position was not detected. In such cases, a preset error signal can be loaded into the frame memory 606. Here, the contrast for each coordinate position was computed based on the contrast of three image data, but the number of image data used does not need to be three, so long as there are multiple images. Of course, using more images allows one to improve S/N.

[0037] The operation of the present invention will be described below. When the object 1 is close to a mirror surface, the images of the texture pattern 403 will be reflected from the object 1 and will be observed as being at position 3. Furthermore, it will be observed as being at position 2 due to lens effects of concavoconvex structures on the surface of the object. Therefore, if the shape of the object surface is determined by detecting images while changing the focal point position, shape 2 will be determined. This shape has been deformed due to reflection effects and lens effects. Thus, to find out the true shape 1, it is necessary to correct for the deformation due to these reflection effects and lens effects. Assuming that the shape deformed due to reflection effects and lens effects, i.e. the detected shape, is $\Delta z(x, y)$, the true shape $\Delta z0(x, y)$ is represented by the above-described formulas (mathematical formula 1) and (mathematical formula 2).

[0038] The image observed as being at position 2 is detected by the detector 502 and subjected to differentiation processing in

differentiation processing circuit 601 and stored in frame memory 602, 603, 604. This differentiation processing is intended to compute the contrast of the detected image, and can be accomplished for example by performing second order differentiation on a 3 (x direction pixel size) × 3 (y direction pixel size) range. Alternatively, second order differentiation of a larger range, such as 5×5 is also possible, and various differential operators other than second order differentiation, such as Laplacian, Laplacian of Gaussian, or first order differentiation may also be used.

[0039] Here, for computation of contrast, if the operator size is matched to the texture pitch P, the S/N of the computation will increase. Therefore, when a texture pattern is projected, it is best to compute the contrast by matching the operator size to the pitch of the texture pattern.

[0040] In FIG. 13, the contrast is computed using differentiation by means of differentiation processing circuit 601, but the contrast may also be computed based on contrast of intensity change of the texture pattern. Specifically, when using the maximum value MAX and MIN adjacent to the detection waveform in FIG. 13, the contrast C is represented by the following formula (mathematical formula 5).

[0041]

$$C = (MAX - MIN) / (MAX + MIN) \quad \text{(mathematical formula 5)}$$

The aforementioned contrast C may be computed using this formula (mathematical formula 5). Using this formula (mathematic formula 5) has the effect of allowing one to compute the contrast with high sensitivity even when the intensity change of the detected waveform is small. However, a need then arises to compute maximum and minimum values, so the computational processing increases. To reduce this computational processing, the signal should be acquired in a manner that matches the period of intensity change, i.e. the spatial period of the texture. To implement this, it is necessary for the period of the texture pattern to be constant. Alternatively, one may compute the period of the texture pattern for each location and perform the contrast computation of the formula (mathematical formula 5) based on the results thereof.

[0042] Furthermore, although one may speak of a mirror surface, in actuality there will be small scratches, foreign matter or concavoconvexities present on the surface, and these can be detected so as to detect the three-dimensional shape based on contrast changes of these detected images. Furthermore, in cases where concavoconvexities of a size about 10 times the image resolution are present on the surface, by detecting these concavoconvexities, it is possible to detect the surface shape based on contrast changes of the detected concavoconvexities. In this case, it is necessary to distinguish if there are concavoconvexities on the surface or if it is background light being reflected from the surface. For this purpose, it suffices to illuminate with white incoherent light from an infinite distance. This is because with such illumination with white incoherent light, light will be emitted in all directions, so the phenomenon of the position of surface concavoconvexities and the like changing suddenly due to lens effects of the concavoconvexities will not occur readily.

[0043] In the above embodiment example, the image reflected by object 1 is detected, so the luminous flux of the reflected image needs to enter the aperture of the lens. In the case of objects with a steep shape, the luminous flux of the reflected image will not enter the aperture of the lens, so it is difficult to detect steep shapes. Thus, a configuration for detecting objects with such steep shapes is shown in FIG. 16.

[0044] The example shown in FIG. 16 comprises a detection optical system 500 and multiple illumination optical systems 405, 406, 407, 408 of the same type as illumination optical system 400 of the configuration shown in FIG. 11. These multiple illumination optical systems 405, 406, 407, 408 each have a different color filter so as to be able to emit different wavelengths. Light from the illumination direction is detected in detection optical system 500 with detectors 502, 503, 504, 505, which detect the corresponding colors.

[0045] Here, as a means of independently detecting light from the respective directions, in the embodiment example shown in FIG. 16, a configuration was employed in which light of different wavelengths is emitted and separated, but this sort of configuration is not necessary for achieving the effect of the present invention. For example, a configuration may also be employed whereby illumination is performed sequentially from each illumination direction and the detection optical system 500 detects signals at the corresponding timing, or a configuration as shown in FIG. 18, comprising an optical system of a configuration including both an illumination optical system 400 and a detection optical system 500, whereby signals are detected at each angle while change the angle of this optical system to the object 1. Here, FIG. 17 (a), (b) and (c) show the detected image from each direction detected with a configuration as shown in FIG. 16. Such an image is detected at each wavelength while changing the texture pattern projection position, and the shape is computed for each wavelength by means of signal processing systems 607, 608, 609, 610. Here, each computed shape is a shape detected with illumination from the direction of the respective illumination optical system, and is thus corrected by direction correction circuit 611 and stored in frame memory 612. The hatched areas represent the portions where the contrast of the detected signal from each direction was at or above a certain value. Specifically, this indicates that there was no light reflected from portions other than the hatched ones. Depending on the object 1, there may be cases where two illumination systems suffice, or cases where four or five systems may be necessary. In any case, the entire field of view has to be covered as necessary. This type of configuration makes it possible to determine the shape of objects having mirror surfaces with steep shapes.

[0046] FIG. 19 illustrates an embodiment example for detecting the surface shape of an object 1 having a smooth, deep diffuse surface without texture on the surface. This embodiment example comprises a illumination optical system 400 of the same type as in the embodiment example of FIG. 11, a detection optical system 500 of the same type as the embodiment example of FIG. 11, having an objective lens drive mechanism 509, and a signal processing system 400 of the same type as in the configuration of FIG. 1. In this embodiment example, the texture pattern 403 is projected to the vicinity 13 of the object 1 through a half-mirror 404 and objective lens 501. The detection optical system 500 is set up so that the focal point is focused on the projected pattern. Here, to change the projection position of the pattern from position 13 to position 14, the objective lens

501 is driven in the optical axis direction by means of the objective lens drive system 509. This configuration makes it possible to focus and project a texture pattern onto objects which are deep in the optical axis direction, where the illumination optical system 400 is not able to focus over the entire surface of the object 1. Here, in this embodiment example, the focal point position during projection can be changed, so there is no need to use an illumination optical system having a large focal depth, as a result making it possible to use an illumination system with a shallow focal depth, in other words, with a high image forming resolution, and making it possible to project texture patterns at a high resolution and to improve the optical detection resolution for three-dimensional shapes.

[0047] FIG. 10 illustrates the numerical aperture of common optical systems and the focal depth and optical resolution corresponding to the numerical aperture, computed using the aforementioned formulas (mathematical formula 3) and (mathematical formula 4). If the numerical aperture N.A. of the illumination optical system 400 is near 0.008, the optical resolution d will be about 76 microns and the focal depth ±h will be about 3.9 mm. Here, if the numerical aperture N.A of the detection optical system 500 is about 0.04, the focal depth ±h will be about 156 microns and the optical resolution d in the planar direction during detection will be about 10 microns. Here, Japanese Unexamined Patent Application Publication H3-63507 discloses a configuration in which the focal depth ±h of the detection system is changed, but in particular in the case of objects having a smooth diffuse surface, it can be seen that one can also reduce the focal depth ±h of the illumination system and change the focal position of the illumination system. Namely, the numerical aperture N.A. of the illumination system 400 is made about 0.03 and a texture pattern of about 100 microns is projected. Since the optical resolution d of the illumination system 400 is about 20 microns, the texture pattern will be projected at a high image resolution. Here, if the numerical aperture N.A. of the detection optical system 500 is made about 0.006, the optical resolution d will be about 100 microns, and it will be possible to ensure a focal depth ±h of 7 mm. Therefore, it will be possible to detect the three-dimensional shape of an object 1 having a smooth diffuse surface.

[0048] Moreover, for example, when an object 1 not having surface texture of about 1 mm in the height direction is detected with a planar optical resolution of about 10 microns, it can be seen from FIG. 10 that there is no suitable projection optical system or detection optical system. In such cases, the numerical aperture N.A. of the illumination optical system 400 and detection optical system 500 are both made about 0.1 to secure an optical resolution d of 6 microns. Furthermore, it is possible to detect multiple images while synchronizing the focal point position of the illumination optical system 400 and the focal point position of the detection optical system 500, and detect the planar shape based on contrast change. With such a configuration, it is possible to detect the three-dimensional shape for objects which are taller in the height direction than the focal depth of the optical system. Furthermore, to detect the shape of objects with a mirror surface, it is necessary to make the focal depth of the illumination optical system 400 shallower, so this sort of configuration in which the focal points of the detection optical system 500 and illumination optical system 400 are synchronized is effective.

[0049] A specific embodiment example of a surface shape detection device of the present invention will be described below using FIG. 1 through FIG. 2. The present embodiment example comprises an illumination system 100 comprising a light source 101, slit 102, half-mirror 103, illumination lens 104 and diffusion plate 106; a detection optical system 200 comprising an objective lens 201, relay lens 202, image forming lens 203, detector 204, spatial filter 205, spatial filter control system 206, variable magnification ratio mechanism 208 and focusing mechanism 209; and a signal processing system 300 comprising a smoothing circuit 301, memories 302, 303, 304, temporal differentiator circuit 305, spatial differentiator circuit 306, velocity detection circuit 307, initial velocity detection circuit 308, hidden line processing circuit 309, integration circuit 310 and velocity memory 311.

[0050] In the illumination system 100, a slit having a pattern such as a lattice, polka-dot pattern, random pattern, speck pattern, etc., is illuminated by the light source 101. This slit 102 is imaged onto the object 1 by the illumination lens 104. Here, a diffusion plate 106 is arranged immediately before the slit 102, making it possible to accommodate illuminance nonuniformities of the light source. The light source 101 can be a conventional white filament lamp, but other light sources, i.e. a fluorescent lamp, halogen lamp, mercury lamp, xenon lamp, etc., may be used as well. Furthermore, an infrared lamp, ultraviolet lamp, etc., or a laser light source such as semiconductor laser, Ar laser, He-Ne laser, etc., may be used as well.

[0051] Furthermore, an objective lens 201 is used here along with the illumination lens 104, but the illumination lens may also be separated from the detection optical system 200 as shown in FIG. 2, or natural light such as sun or moon light may be employed as well.

[0052] In the detection system 200, light emitted from the object 1 is guided by means of objective lens 201, relay lens 202 and imaging lens 203 to a detector (photoelectric conversion means) 204 and a two-dimensional image of the object 1 is formed on the detector 204. A spatial filter 205 is inserted into this optical system. This spatial filter 205 is best set at a position of Fourier transform of the object 1 by the optical system, but may also be at a position immediately before or immediately after the objective lens 201, or immediately before or after the imaging lens, or at the focal point position of the objective lens. The spatial filter 205 has a circular aperture 207, as shown in FIG. 3, the radius r and position x, y of the aperture 207 are controlled by a spatial filter control system 206, and control is provided so as to change (move) the detection position or detection direction δ with respect to a point on the object 1. The control method here may employ a liquid crystal display element, or r may be controlled with an iris diaphragm and x, y may be controlled with an XY stage. The aperture 207 used here was circular, but it does not necessarily have to be circular, and may alternatively be square, rectangular, oval or another shape. Furthermore, the detection system 200 changes the image forming magnification ratio of the image formed on the detector 204 by means of a variable magnification ratio mechanism 208, and control can be provided so that the detection position or detection direction δ changes (moves) with respect to a point on the object 1. This

variability of magnification ratio makes it possible to achieve the technical object of the present invention of making the resolution of the image formed on the detector greater than the pixel size of the detector. At the same time, this mechanism achieves the effect of making it possible to detect a portion of the object in enlarged form. Furthermore, the detection system 200 has a focusing mechanism 209, and is designed to form an image of the object 1 on the detector 204 (coordinate x on detector 204).

[0053] Here, by operating the aperture 207 at a constant velocity, the position δ of the viewpoint from which the object 1 is viewed is ultimately moved, making it possible to change the position of the image formed on the detector (photoelectric conversion means) 204 having the coordinate x. This operation enables movement of the position δ of the viewpoint (changing the detection position or detection direction), as will be described later using FIG. 9. Here, the detector 204 has a pixel size w that is set to be smaller than the optical resolution of the imaging optical system comprising the objective lens 201, relay lens 202 and imaging lens 203, and is configured such that the image signal outputted from the detector (photoelectric conversion means) 204 is acquired as a continuous light intensity change. Furthermore, the dynamic range of the detector 204 is set to be greater than a value which will be described later.

[0054] The detector 204 can of course be either a one-dimensional sensor or a two-dimensional sensor.

[0055] In the signal processing system 300, the signal which has passed through the smoothing circuit 301 is split into a signal propagation path comprising memories 302, 303, a signal propagation path comprising memory 304, and a signal propagation path comprising no memory. The smoothing circuit 301 eliminates high frequency noise (steep image signals) of the detection signal, making the intensity change of the image signals sufficiently gradual to allow differentiation with respect to positional coordinates, and can be left out if noise (steep image signals) is not a problem. The memories are all so-called frame memories, which store one frame's worth of image information i. As a result, information which has passed through memory 304 is information from one frame prior to the information which has passed through the smoothing circuit 301, and information which has passed through memory 303 is information from one frame prior to the information which has passed through memory 304. Based on these three items of information, the image signal (light intensity distribution of detected image) i is temporally differentiated (di/dt) for each positional coordinate in the frame memory by means of temporal differentiator circuit 305. At the same time, the signal i from the smoothing circuit 301 is spatially differentiated (di/dx) by means of spatial differentiator circuit 306, and the inverse (dx/di) thereof is outputted. Based on the signals (di/dt), (dx/di) outputted from these differentiator circuits 308, 306, the velocity (dx/dδ) is detected by velocity detection circuit 307 according to the formula (mathematical formula 7), described later. If the movement velocity (dδ/dt) of the viewpoint position δ, described later, is set to constant velocity motion, this will be a constant and can be preset, but even if constant velocity is not set, it is possible to set this in advance as the desired profile by means of the spatial filter control system 206 or variable magnification ratio mechanism 208, or else a measurement means may be provided and the movement velocity based on aperture 207 controlled by spatial filter control system 206 or the movement velocity based on the imaging magnification ratio varied by the variable magnification ratio mechanism 208 can be measured and computed.

[0056] Based on the velocity (dx/dδ) detected as described above, the velocity at each point during initial velocity (the velocity (dx/dδ) at time t0) is computed by initial velocity detection circuit 308. Hidden line processing is then carried out by hidden line processing circuit 309, the signal outputted at each time point is integrated by the integration circuit, and is stored in velocity memory 311. Information inside the velocity memory 311 is converted to height information z based on the relationship of formula (mathematical formula 6), described later.

[0057] The operation of the present invention will be described below. An object 1 is illuminated with light emitted from the light source 101. The light applied by illumination is emitted from the object 1 in various directions according to the object's shape. Here, depending on the surface state of the object 1, the emitted light will be emitted in diffracted, scattered or reflected form, or, in many cases, in a form that combines these phenomena. Here, when the object 1 has the form shown in FIG. 4, due to the concavoconvex shape of the surface, the reflectance distribution of the surface or the fine shape of the surface, the intensity of emitted light has a distribution at each point in each emission direction. As a result, the signal which, based on the emitted light, has passed through detection optically system 200 and has been imaged on the detector 204, and has passed through detector 204 having coordinate x and has passed through smoothing circuit 301, will have an intensity distribution i as shown in FIG. 5.

[0058] The signal (di/dx) obtained by differentiating this signal (light intensity) i with respect to the detection position x by means of spatial differentiator circuit 305 is the signal shown in FIG. 6. Furthermore, the signal (di/dt) obtained by differentiation by temporal differentiator circuit 305 is the signal shown in FIG. 7. Furthermore, based on the formula (mathematical formula 7), described later, the velocity (dx/dδ) is computed by velocity computation circuit 307, and based on this velocity, the three-dimensional shape is detected as height information z, corresponding to the detection location as shown in FIG. 8, by means of the formula (mathematical formula 6), described later. Here, for the velocity detection, computation is performed according to the basic principle indicated below, but there is a need to take the inverse (dx/di) of the signal produced by the spatial differentiator circuit 306, and when this spatial differentiation signal (di/dx) is 0 or a value close to 0, since zero division (dividing by 0) is not possible, it is not possible to detect the velocity (dx/dδ) with this velocity detection circuit 307. Thus, the spatial differentiator circuit 306 is designed to perform differentiation with a sufficient distance x such that the derivative does not become a value close to 0. Namely, if the optical detection resolution of the detector 204 is made greater than the image forming resolution of the imaging optical system including the imaging lens 203, etc., the spatial derivative can be prevented from becoming a value close to 0. Furthermore, steep signal components are eliminated from the detection

signal in the smoothing circuit 301 so that the spatial derivative does not become a value close to 0.

[0059] However, in the case of signals for which the spatial derivative (di/dx) cannot be made into a sufficiently large value even with a sufficient distance x, the velocity detection circuit 307 outputs a signal called "velocity detection impossible". Based on a velocity signal (dx/dδ) computed as described above, the three-dimensional shape of the object 1 is computed as shown in FIG. 8 using the formula (mathematical formula 6), described later.

[0060] The basic principle of the present invention is illustrated in FIG. 9. The case is illustrated where an object 1 has been observed from viewpoint A and from viewpoint B, which is a very small distance away from viewpoint A. In this case, P1 and P2 on the object are observed respectively after movement in directions $\theta 1$, $\theta 2$ with reference to the directions of P1, P2 from viewpoint A. Namely, the object 1 is detected on the detector 204 as a graphic shape projected and imaged onto a virtual plane

$$z = f(v) = f(dx/d\delta)$$

Here, f(v) is a function of the detection optical system (objective lens 201, relay lens 202, imaging lens 204, etc.). Specifically, it is linear when δ is sufficiently small. When δ is large, it becomes a correction function based on the view angle $\theta 1$, $\theta 2$ of P1, P2 from viewpoint B. The linear coefficient, etc. involved here are determined separately according to the specification of

$$dx/d\delta = (dx/di) \cdot (di/d\delta)$$
$$= (dx/di) \cdot (di/dt) \cdot (dt/d\delta)$$

Here, in order for the variable separation formula (mathematical formula 7) to obtain, i needs to be a function of x, δ, namely, i(x, δ), x needs to be a function of i, and i needs to be a function of δ, and each of these needs to be differentiable. As such a function i, one can approximately, and in special cases, take the light intensity distribution of the detected image. Here, dx/di is the inverse of the spatial derivative (di/dx) obtained by differentiating light intensity i with respect to the positional coordinate x of the detected image.

[0065] Alternatively, there can be cases where i is a function x and di/dx does not become 0. Here, the thinking is necessary that treats this problem not just as a matter of natural science but also as a matter of engineering. Namely, it is necessary to actively create a state where di/dx does not become zero, as well as a state where di/dx does not become infinite (a differentiable state).

[0066] The method of creating this state in which di/dx does not become 0 is a function of the spatial differentiator circuit 306 described earlier. Furthermore, for computation of di/dx, it is necessary to make dx sufficiently large so that di will be sufficiently large. In the case of a detection optical system as shown in FIG. 1, which detects a signal while changing the detection direction, this condition is satisfied by using a sufficiently long sampling time. Specifically, as shown in FIG. 1, the spatial differentiator circuit 306 comprises a differentiator circuit 313, derivative integration circuit 314 and integral evaluation circuit 315. Here, the image signal is differentiated by the differentiator circuit 313, and the results are integrated by the derivative integration circuit 314. This integral is evaluated by the integral evaluation circuit 315 as to whether it is a value sufficiently greater than 0, and is integrated by the derivative 2 from viewpoints A and B. That is, the points P1, P2 are detected on the detector 204 as if they have moved at a certain angular velocity. Computing this angular velocity is important for the present invention. As a result, the projected image P11 which images P1 is detected as if it has moved to P12, and the projected image P21 which images P2 is detected as if it had moved to P22. Assuming the amount of such movement is x1, x2 (coordinates on the detector 204), the three-dimensional shape of the object 1, i.e. the depth z1, z2 will be the function f(v1), f(v2) of the rate of change v1, v2 of x1, x2 for an amount of movement δ of the viewpoint. Therefore, the rate of change v for the amount of movement at all observed points should be determined.

[0061] Based on the foregoing, the three-dimensional shape of the object 1 can be determined by computing the rate of change v of the amount of movement. Namely, the following formula (mathematical formula 6) obtains.

[0062]

(mathematical formula 6)

the detection optical system, etc.

[0063] Next, it will be described how the formula (mathematical formula 6) is found. Furthermore, the following formula (mathematical formula 7) is obtained through separation of variables.

[0064]

(mathematical formula 7)

integration circuit 315 [sic: 314] until it becomes a value sufficiently greater than 0.

[0067] Similarly, in the temporal differentiator circuit 305, the derivative produced by differentiator circuit 316 is integrated by derivative integration circuit 318. Using the integral evaluation circuit 317, it is evaluated if this integral is sufficiently greater than 0, and integration is performed by the derivative integration circuit 318 until it becomes a value sufficiently greater than 0.

[0068] Furthermore, a method of creating a state where di/dx does not become infinite is an optical system wherein the optical resolution of the detector is made higher than the optical resolution of the detection optical system and spatial differentiator circuit 306 described previously. By making the optical resolution of the detector greater than the optical resolution of the detection optical system and setting the movement distance of the detected image during the sampling time for computation of di/dx about the same as or sufficiently smaller than the optical resolution, the spatial differentiability of i above will be maintained even in the case of edges, etc., where differentiation was not possible with conventional methods. Specifically, when the detector 204 is a charge transport type detector, the detector's accumulation time will be the sampling time. Therefore, the accumulation time is set such that the movement distance of the detected image due to movement of the spatial filter 205 during the accumulation time will be smaller than the aforesaid optical resolution of the detection optical system.

[0069] The above differentiation and integration circuits and evaluation circuits may be implemented as digital circuits or as analog circuits.

[0070] Furthermore, when the movement velocity dδ/dt of the detection optical system 200 or spatial filter 205 is fixed,

namely, in the case of constant velocity motion V0, the velocity dx/dδ (relative to the amount of movement dδ) on the image

$$dx/d\delta = (dx/di) \cdot (di/dt) \cdot (1/V0)$$
$$= k \cdot (dx/di) \cdot (di/dt)$$

where (dx/di) and (di/dt) can be computed respectively in the spatial differentiator circuit 306 and temporal differentiator circuit 305, thus making it possible to compute the velocity dx/dδ. If dδ/dt is not a constant velocity, it is necessary to compute dδ/dt as well using the formula (mathematical formula 7).

[0071] It will be noted that when dδ/dt is not a constant velocity, the velocity of the detection optical system 200 or spatial filter 205 should be measured with some sort of measurement means. Furthermore, velocity computed based on data from the control driving system may be used.

[0072] The computation indicated in the formula (mathematical formula 7) is then carried out in the velocity computation circuit 307, computing the velocity at each point.

[0073] A method was described above in which the optical resolution of the imaging optical system was made lower than the optical resolution of the detector 204, and the optical resolution of the optical system was made worse in the optical system as a means of making the detected image planarly (spatially) differentiable, but other methods may be used as well. For example, an image signal acquired by an optical system with high optical resolution can be subjected to planar smoothing in the smoothing circuit 301. Once smoothing is performed, a blurred image signal is obtained as if the optical resolution of the optical system had been low. For the smoothing process here, convolutional integration can be performed on the range Xn × Yn, where Xn is the number of pixels in the X direction and Yn is the number of pixels in the Y direction, or the high frequency component can be cut off in the Fourier transform region.

[0074] The initial velocity detection circuit 308 computes the velocity (dx/dδ) at each point at a given time t0 based on the results for each time above. Subsequently, the hidden line processing circuit 309 recognizes the portion within the signal at each time t that should not be visible at time t0. Integration circuit 310 integrates the velocity at time t0 computed based on data from each time t excluding the portion that should not be visible. This procedure reduces noise. The result is stored in velocity memory 311.

[0075] Based on the information in this velocity memory 311, the three-dimensional shape z of the object 1 is computed by the CPU 312 using the correction function f(v) indicated in the formula (mathematical formula 6).

[0076] In the foregoing, the angular velocity of each point in the image due to movement in the planar direction of the spatial filter 205 is computed as the movement of the image, but in computation of three-dimensional shape, which is the purpose of the present invention, one may also move the detection optical system 200 itself, beside the detector 204, in either the planar or optical axis direction (toward or away from the object 1) or change the magnification ratio by means of the variable magnification ratio mechanism 208, as a result of which the image will move and the velocity can be computed using the formula (mathematical formula 7) based on this movement.

[0077] The present invention, as described above, is characterized in that, to detect the three-dimensional shape of an object, depending on the surface texture of the object, the plane detected by the detector 204 will be, according to the formula (mathematical formula 7)

(mathematical formula 8)

optical resolution of the detection optical system, the detection field of view and the sampling interval during detection are changed, and the resulting data is detected and processed. In other words, the invention is characterized in that image information is detected while changing the spatial resolution and temporal resolution of the detected image in substantially automatic fashion in accordance with the object. Namely, the configuration is such that, for computation of the spatial rate of change (di/dx) and temporal rate of change (di/dt), the sampling time is controlled such that the time until the next sampling (the sampling time for computation of spatial rate of change) will be sufficiently long to ensure a sufficient amount of spatial movement dδ during such time for the spatial rate of change to become sufficiently large, but such that sampling time will be sufficiently short so that the spatial rate of change (di/dx) does not become infinite for steep portions such as edges, in other words, sufficiently short to allow computation.

[0078] The element technology of the present invention as described above consists in a detector with high optical resolution and high dynamic range. The method of implementing a detector with high dynamic range will be described below.

[0079] To implement this, it is particularly desirable to provide the aforementioned spatial differentiator circuit 306 and temporal differentiator circuit 305 immediately after the signal of the detector 204, specifically, immediately after the photoelectric conversion of the detector, that is, within the chip of the detector. In this case, while it is possible to use a temporal differentiator circuit using memory as shown in FIG. 1, a circuit which performs temporal differentiation directly on analog data is preferable. Implementing such a circuit essentially makes differentiation possible even in cases where the derivative becomes extremely large, such as with edges on the image, by reducing the dt used for differentiation. Furthermore, in order to prevent the value of spatial differentiation (di/dx) from becoming 0, a detector with a large dynamic range is necessary, and this can be implemented with a configuration which outputs a spatial derivative.

[0080] Furthermore, FIG. 24 illustrates an embodiment example which implements such spatial and temporal differentiation within a chip. This embodiment example comprises two pairs of photoelectric conversion means 810, 820, a wire 830, and a wire 840. The photoelectric conversion means 810, 820 each comprises a positive electrode 811, 821 and a negative electrode 812, 822. The positive electrode of one is connected to the negative electrode of the other. Based on this configuration, a difference occurs in the terminals 851, 852 between the charge converted by photoelectric conversion means 810 and the charge converted by photoelectric conversion means 820. The above differentiation means 853 includes these photoelectric conversion means 810, 820.

[0081] By arranging these photoelectric conversion means 810, 820 on a plane, as shown in FIG. 25, or by arranging them as shown in FIG. 26 (a), (b), or by arranging them in a package 854 as shown in FIG. 27 (a), (b) to create a one-dimensional sensor, it becomes possible to detect, between the terminals 851, 852, the derivative of light which is detected between the

photoelectric conversion means 810, 820. Such a configuration makes it possible to acquire a spatial derivative of the image on the detector. Such a configuration not only has the effect of allowing a derivative to be obtained on the detector, but as a result of being able to directly obtain derivatives, also has the effect of making it possible to acquire the difference (differentiation) between detectors at high accuracy. Furthermore, it allows differentiation computations to be performed at high speed.

[0082] Furthermore, FIG. 28 (a), (b), (c) illustrates a configuration which implements spatial differentiation and temporal differentiation on a detector. Spatial differentiation is implemented by the means shown in FIG. 25, and temporal differentiation is performed by a photoelectric conversion means 860 and differentiation means 870 installed in parallel therewith. Specifically, the differentiation means 870 can be implemented for example by measuring the voltage arising at both ends of a small coil 871, as shown in FIG. 29. Alternatively, as shown in FIG. 30, it may comprise photoelectric conversion means 880, 890, charge accumulation means 910, 920, and a switch 930. The charge detected by the photoelectric conversion means 860 is supplied to positive electrodes 911, 921 and negative electrodes 912, 923 connected to opposite poles of each other, and the differentiation result is outputted between the terminals 931, 932.

[0083] Furthermore, a unit cell 855 which performs the aforementioned temporal differentiation (di/dt) and spatial differentiation (di/dx) on a detector may be arranged on the top surface of the detector as shown in FIG. 31, with the velocity detection circuit 307 illustrated in FIG. 1 being arranged on the back surface thereof, with the division result, i.e height information, thus obtained being outputted by a transfer means 858 serially in the direction of 856 or in parallel in the direction of 857. As an example of this velocity detection circuit 307, a configuration in which the temporal differentiation result is divided by the spatial differentiation result is suitable, whereby the output of unit cell 855 is divided for each unit cell. Such a configuration makes it possible to implement the entire process in a chip. This not only makes it possible to make the processing means more compact, but also makes it possible to construct a processing means with less noise and thus greater dynamic range. Such a configuration is close to the configuration of a human eye. Furthermore, while this configuration may be configured as a three layer structure in the vertical direction of the detector as shown in FIG. 31, if fabricating a three layer structure is difficult, the components may also be arranged in plane. Configuring as a three layer structure in this manner allows for a greater ratio of the surface area of the photoelectric conversion means relative to the detector surface, providing for greater efficiency of detection as compared to an in-plane configuration.

[0084] It has been experimentally confirmed that if coherent light is used as the light source, sharp changes in light intensity will occur due to interference when focus is lost, and contrast change may not correspond to light intensity change. Thus, in the above embodiment example, it is preferable to use light not subject to interference as the illumination light, i.e. temporally and spatially incoherent light. Specifically, white light of a large light source size is preferable.

[0085] In the above embodiment example, differentiation processing is used when computing contrast and when computing image movement velocity. Differentiation processing is susceptible to noise and requires a large dynamic range.

[0086] An embodiment example of a detector for increasing the dynamic range will be described below using FIG. 20. The present embodiment example comprises a light detection and accumulation means 710, saturation detection means 720, charge supply means 730, charge accumulation means 740, charge supply cutoff means 750, charge transfer means 760, 770, and light quantity computation means 780. The light is detected and accumulated by the light detection and accumulation means 710. Here, when the light detection and accumulation means 710 becomes saturated, it is detected by the saturation detection means 720 that saturation has occurred, and charge accumulation from the charge supply means 730 to the charge accumulation mean 740 is cut off by the charge supply cutoff means 750. Charge is then moved from the light detection and accumulation means 710 and charge accumulation means 740 to the respective charge transfer means 760, 770. The light quantity is computed based on the signals transferred to the light quantity computation means 780 by the charge transfer means 760, 770.

[0087] Here, identical processing is performed if there are multiple light detection units, as shown in FIG. 20. Here, the saturation detection means 720 may have a configuration wherein an electrode 721 which detects charge that has overflowed from the light detection and accumulation means is formed at the periphery of the photoelectric conversion means 710, as shown in FIG. 21, or it may be detected that charge transport from the light detection and accumulation means 710 to the charge transfer means 770 has become saturated and ceased and current has stopped flowing, as shown in FIG. 22. In this case, in the saturation detection means 720, for example, an element with a resistor can be arranged between positive electrode 711 of light detection and accumulation means 710 and positive electrode 771 of charge transfer means 770, and the voltage arising at the two ends thereof can be measured.

[0088] Here, in the present invention, it has been shown that by carrying out the differentiation of detected light intensity in the planar direction and differentiation of detected light intensity in the time direction in an analog circuit state, a configuration can be implemented which allows more fine changes to be captured. The present embodiment example may also be configured with components such as transistors and capacitors, but the beneficial effect is further increased if these are incorporated as solid state elements. Furthermore, by using the results of the above-described differentiator circuit as the output of light detection and accumulation means 710 shown in FIG. 20, the dynamic range of differentiation is further improved.

[0089] Furthermore, the dynamic range improvement means and differentiation means presented here provide the aforesaid novel effects of dynamic range improvement, etc. not just for the three-dimensional shape measurement means described above but also for general purpose light detection means.

[0090] Furthermore, the above three-dimensional shape detection method can also be employed with a detection head 999 separated from the controller 998, as shown in FIG. 23. The effect of the present invention is especially well suited for shape recognition of distant objects, as shown in FIG. 10. Therefore, by configuring as shown in FIG. 23, for example, the device can be installed in an automobile to detect the road shape and road condition and can be coupled to the steering device to create an automatic steering device. By implementing such a configuration, it is possible, for example, to prevent falling

asleep while driving, and the like. Furthermore, by prioritizing human steering, the risks of machine malfunction and the like can be avoided. Furthermore, in cases where three-dimensional structures such as guard rails have been formed, the present invention can easily achieve its function given the configuration of the present invention. Furthermore, if a movable spatial filter is installed at the position of the pupil of the optical system in the detection head 999, three-dimensional shapes can be measured with the detection head 999 fixed in a static state, but if the detection head 999 itself moves, there is no need for the movable spatial filter, although it can of course be present as well. However, in the case of a detection head for installation in an automobile, where objects will be moving at high speed, moving the movable filter will conversely increase the measurement time and may make it impossible to achieve the target measurement accuracy. Moving things are easier to find. This is one piece of evidence that derivatives hold an important key.

[0091] Moreover, in the medical field, for example, in dental treatment, it is possible to create a device to measure the shape of a cavity after drilling. In this case, the detection head 999 should be made compact. Furthermore, by using it in conjunction with an endoscope, it is possible to advantageously perform observation and measurement of recessed areas inside the oral cavity, etc.

[0092] Moreover, the present invention can be broadly employed for industrial purposes. For example, in component assembly operations, it can measure the position and shape of a component to enable grasping thereof by an automated machine to implement component assembly.

[0093] Furthermore, the present invention enables measurement of three-dimensional shapes by making the pixel size smaller than the optical resolution of the detection optical system. Therefore, especially when measuring wide scenes, there are cases where it is best, first, to reduce the aperture of the diaphragm of the detection optical system or smooth the detected signal in the planar direction and perform measurement at lower optical resolution, and second, to measure the target area which one wishes to measure at a high optical resolution. These are in particular cases where high speed measurement is required, or cases where the object has a texture pattern of about the same size as the optical resolution of the detector.

[0094]

[Effect of the invention] According to the present invention, in the case of objects without texture on the surface, objects having a surface close to a mirror surface, objects having a smooth diffuse surface or objects with a large depth extent, a texture pattern can be projected onto the surface with high accuracy in the in-plane direction and in the direction perpendicular to the plane, thus enabling high accuracy shape detection for objects ranging from fine objects to large objects.

[Brief description of the drawings]

[FIG. 1] is a block diagram illustrating an embodiment example of the present invention.

[FIG. 2] is a block diagram illustrating another embodiment example of an illumination system.

[FIG. 3] is a plan view illustrating the shape of a spatial filter.

[FIG. 4] is a side view illustrating the shape of an object of detection.

[FIG. 5] is a drawing illustrating the intensity distribution of a single scan line of a detection signal.

[FIG. 6] is a drawing of the signal of FIG. 5 differentiated with respect to the detection position x.

[FIG. 7] is a drawing of the signal of FIG. 5 differentiated with respect to the detection time t.

[FIG. 8] is a drawing illustrating the results of velocity detection.

[FIG. 9] is a block diagram explaining the basic principle of the present invention.

[FIG. 10] is a drawing illustrating focal depth and optical resolution in relation to numerical aperture.

[FIG. 11] is a block diagram illustrating an embodiment example of the present invention.

[FIG. 12] is a drawing illustrating the cross-section of an object.

[FIG. 13] is a drawing illustrating a detection signal.

[FIG. 14] is a drawing illustrating the result of detection signal differentiation.

[FIG. 15] is a drawing illustrating contrast change at different coordinate positions.

[FIG. 16] is a drawing illustrating another embodiment example of the present invention.

[FIG. 17] is a drawing illustrating an example of an image detected by the embodiment example of FIG. 16.

[FIG. 18] is a drawing illustrating another embodiment example of the present invention.

[FIG. 19] is a drawing illustrating another embodiment example of the present invention.

[FIG. 20] is a block diagram of a detector of the present invention.

[FIG. 21] is a plan view block diagram of a saturation detection means of the present invention.

[FIG. 22] is a side view block diagram of a saturation detection means of the present invention.

[FIG. 23] is an external view of another embodiment example of the present invention.

[FIG. 24] is a side view block diagram of a basic chip for spatial differentiation.

[FIG. 25] is a plan view block diagram of an embodiment example in which a basic chip for spatial differentiation has been arranged.

[FIG. 26] is a plan view block diagram of an embodiment example in which a basic chip for spatial differentiation has been arranged.

[FIG. 27] is a plan view block diagram of an embodiment example in which a basic chip for spatial differentiation has been arranged.

[FIG. 28] is a plan view block diagram of an embodiment example in which a basic chip for spatial and temporal differentiation has been arranged.

[FIG. 29] is a block diagram of a basic chip for temporal differentiation.

[FIG. 30] is a side view block diagram of a basic chip for temporal differentiation.

[FIG. 31] is a side view block diagram of an embodiment example wherein velocity detection is implemented inside a chip.

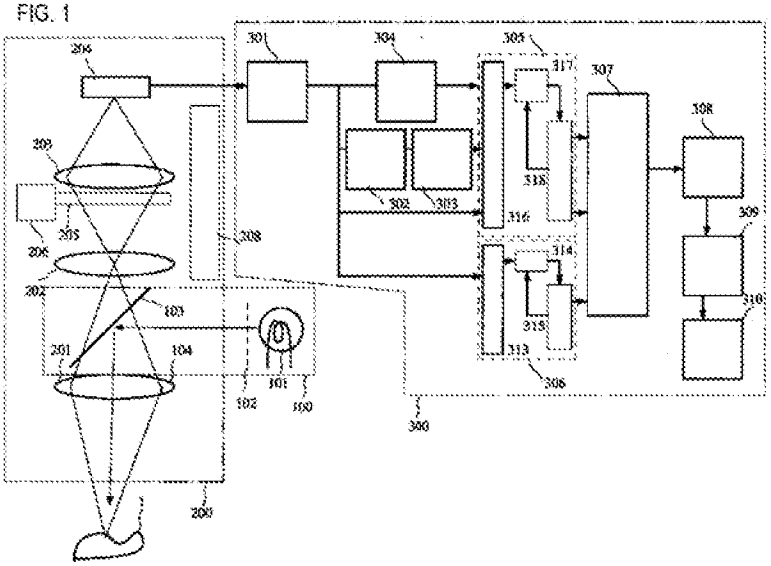
[Description of reference symbols]

1 ··· object, 100 ··· illumination system, 101 ··· light source, 102 ··· slit, 103 ··· half-mirror, 104 ··· illumination lens, 200 ··· detection optical system, 201 ··· objective lens, 202 ··· relay lens, 203 ··· imaging lens, 204 ··· detector, 205 ··· spatial filter, 206 ··· spatial filter control system, 300 ··· signal processing system, 301 ··· smoothing circuit, 302, 303, 304 ··· memory, 305 ··· temporal differentiator circuit, 306 ··· spatial differentiator circuit, 307 ··· velocity detection circuit, 308 ··· initial velocity

detection circuit, 309 ··· hidden line processing circuit, 310 ··· integration circuit, 311 ··· velocity memory, 400 ··· illumination optical system, 500 ··· detection optical system, 600 ··· signal processing system, 403 ··· texture pattern, 502 ··· detector, 601 ··· differentiator circuit, 602, 603, 604, 606 ··· frame memory

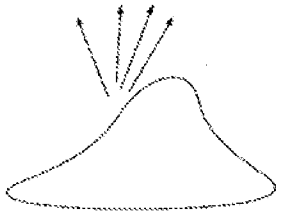
[FIG. 1]

FIG. 1



[FIG. 4]

FIG. 4



[FIG. 21] [FIG. 29] [FIG. 3]

FIG. 21 FIG. 29

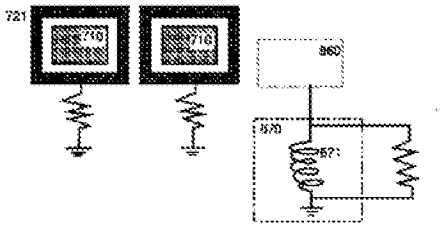
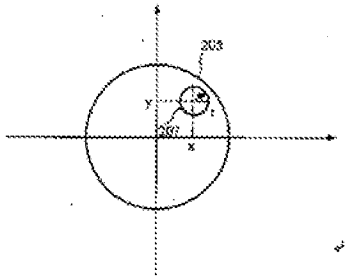


FIG. 3



[FIG. 5] [FIG. 22]

FIG. 5

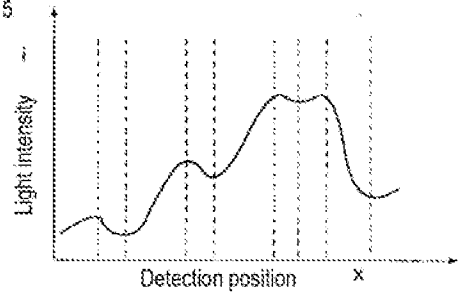
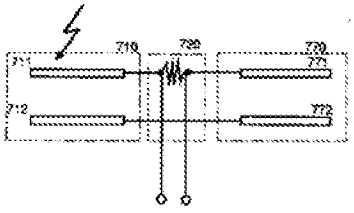
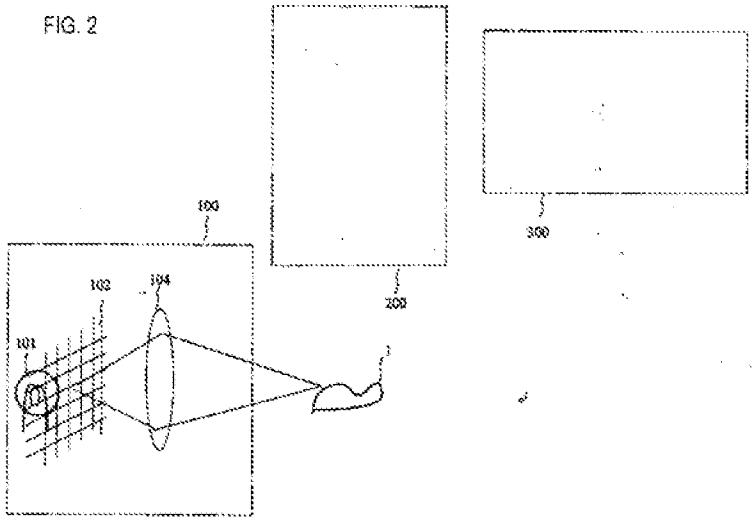


FIG. 22



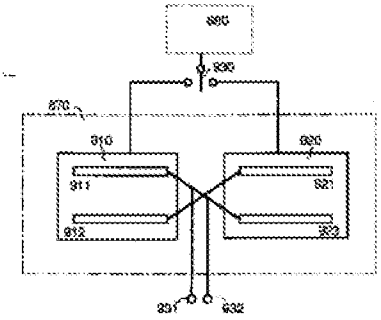
[FIG. 2]

FIG. 2



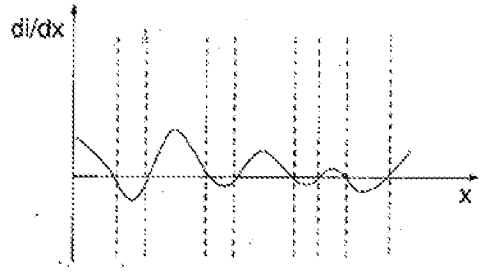
[FIG. 30]

FIG. 30



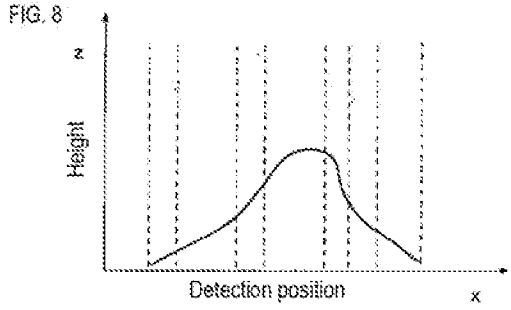
[FIG. 6]

FIG. 6



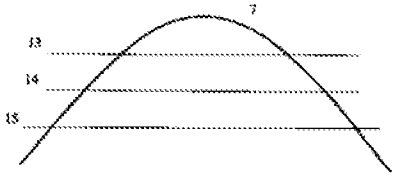
[FIG. 8]

FIG. 8



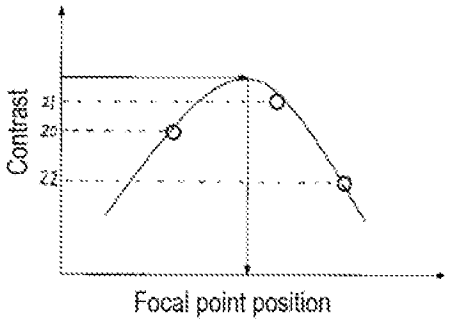
[FIG. 12]

FIG. 12



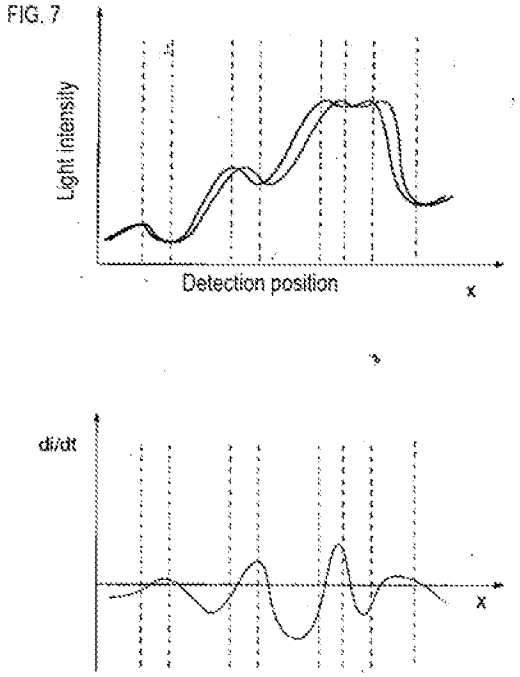
[FIG. 15]

FIG. 15



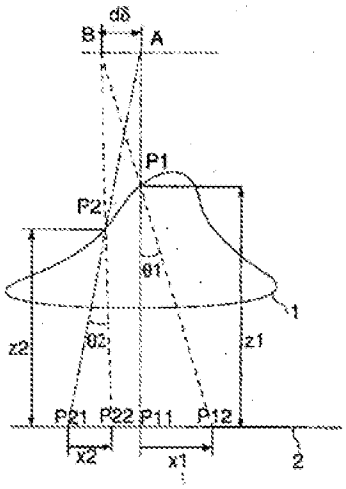
[FIG. 7]

FIG. 7



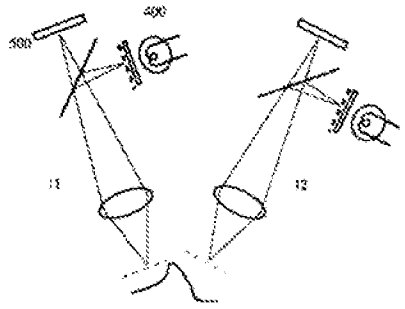
[FIG. 9]

FIG. 9



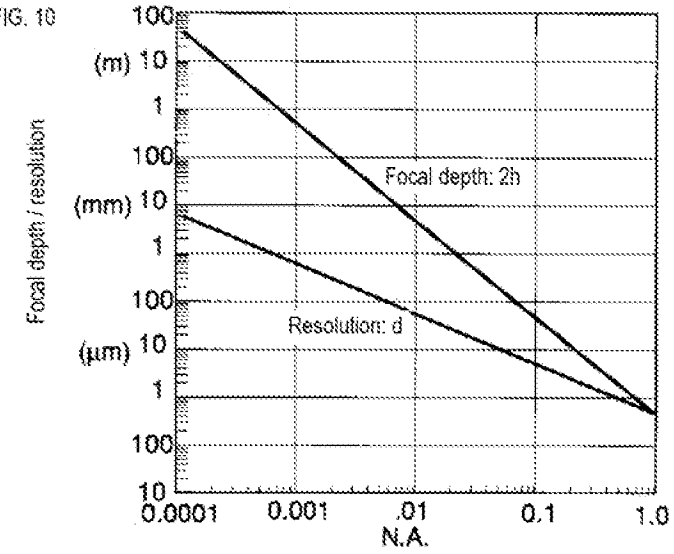
[FIG. 18]

FIG. 18



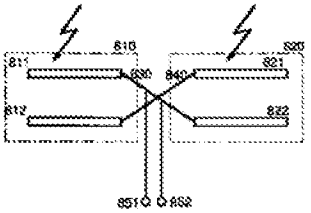
[FIG. 10]

FIG. 10



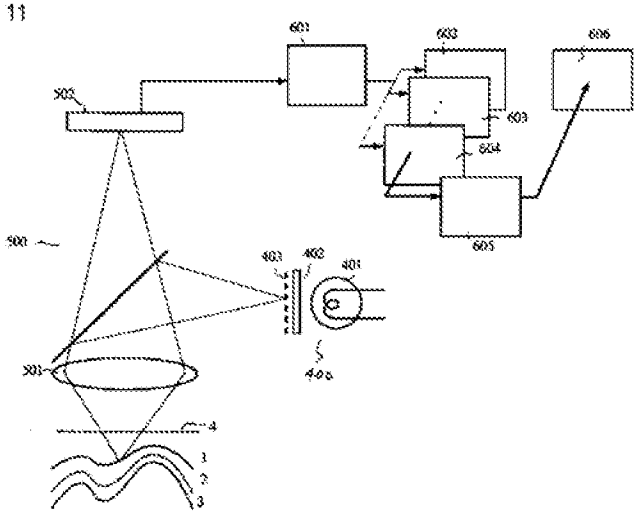
[FIG. 24]

FIG. 24



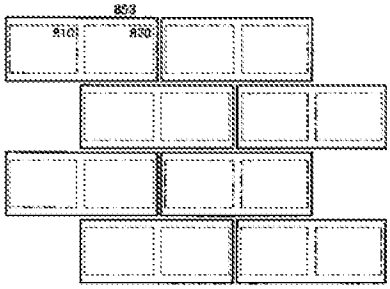
[FIG. 11]

FIG. 11



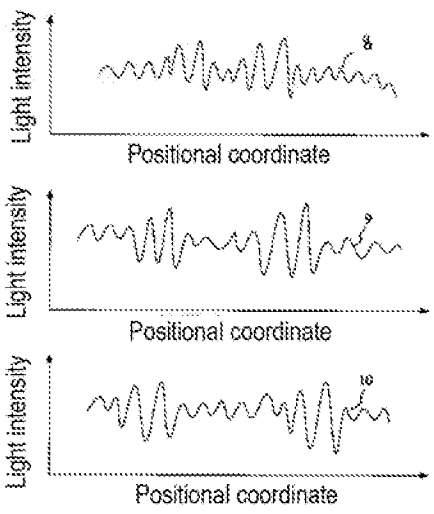
[FIG. 25]

FIG. 25



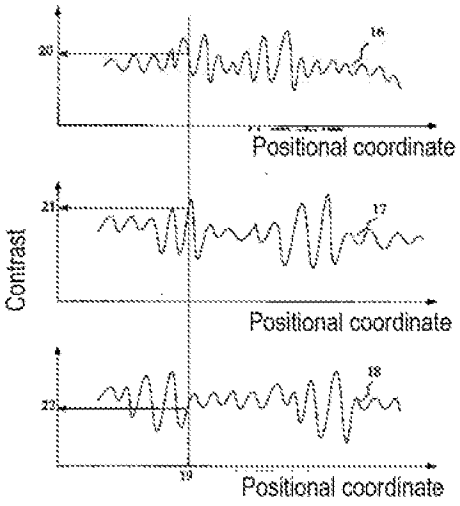
[FIG. 13]

FIG. 13



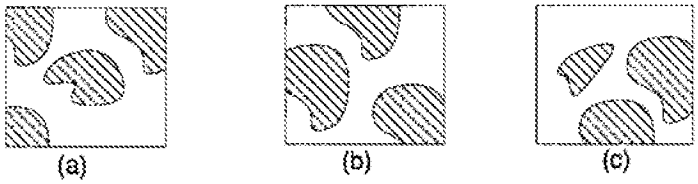
[FIG. 14]

FIG. 14



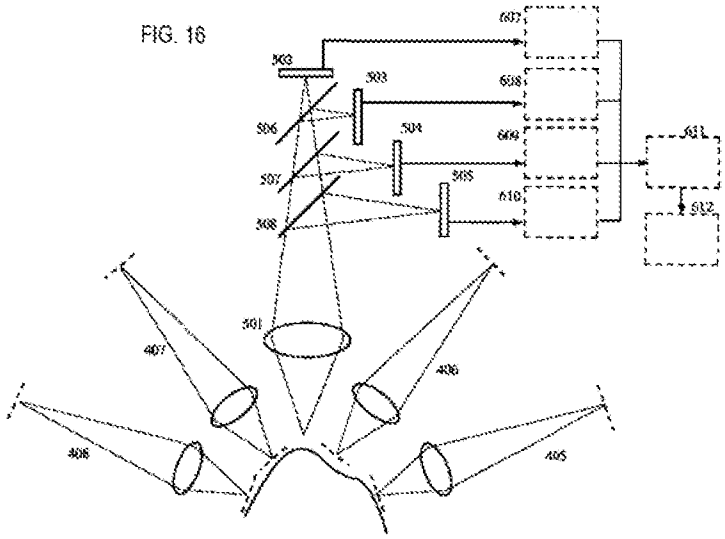
[FIG. 17]

FIG. 17



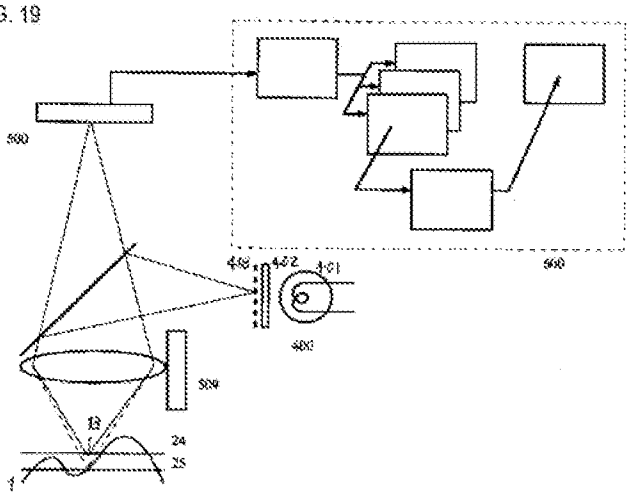
[FIG. 16]

FIG. 16



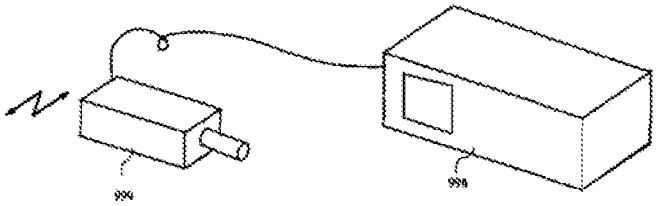
[FIG. 19]

FIG. 19



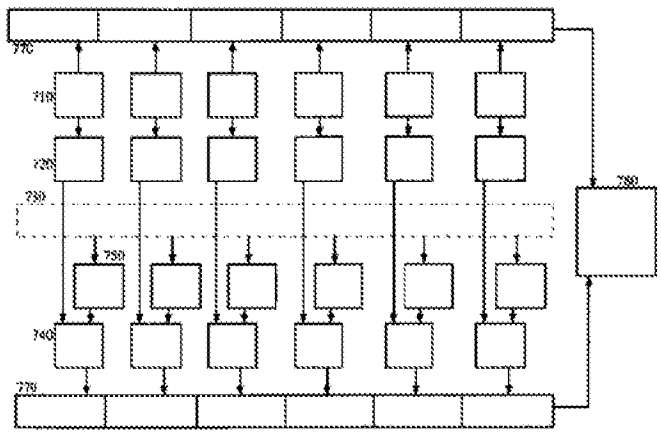
[FIG. 23]

FIG. 23



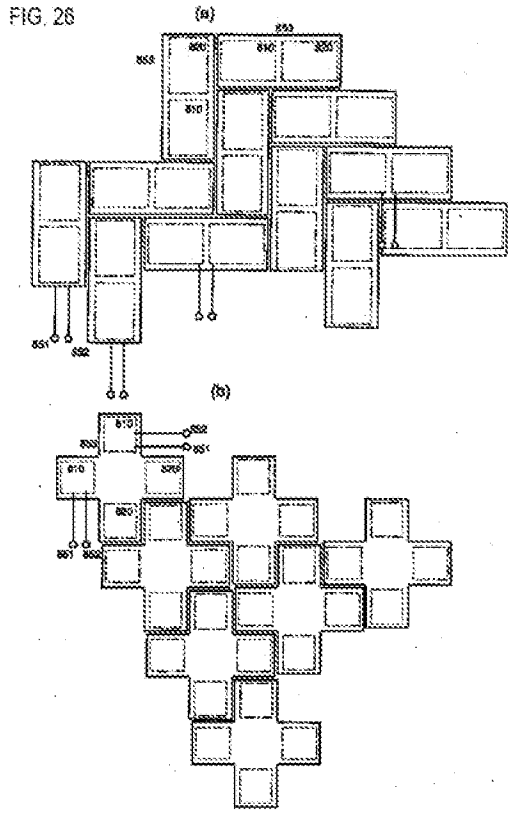
[FIG. 20]

FIG. 20



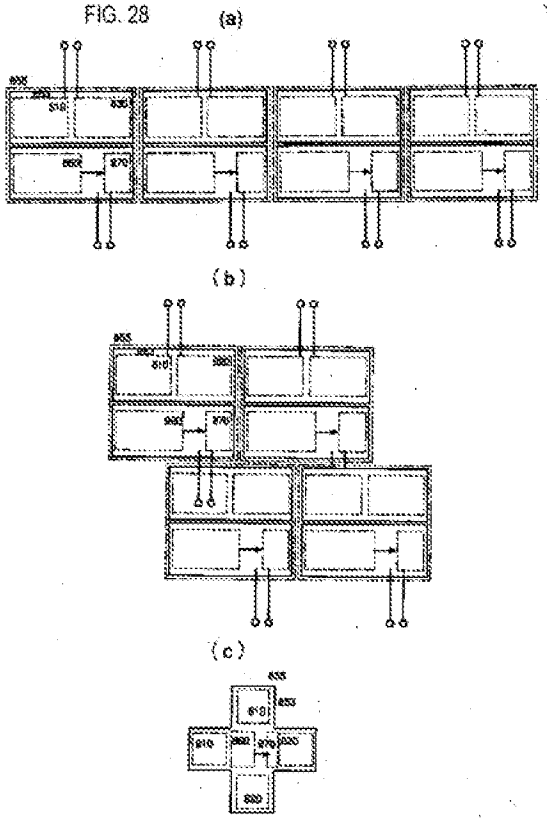
[FIG. 26]

FIG. 26



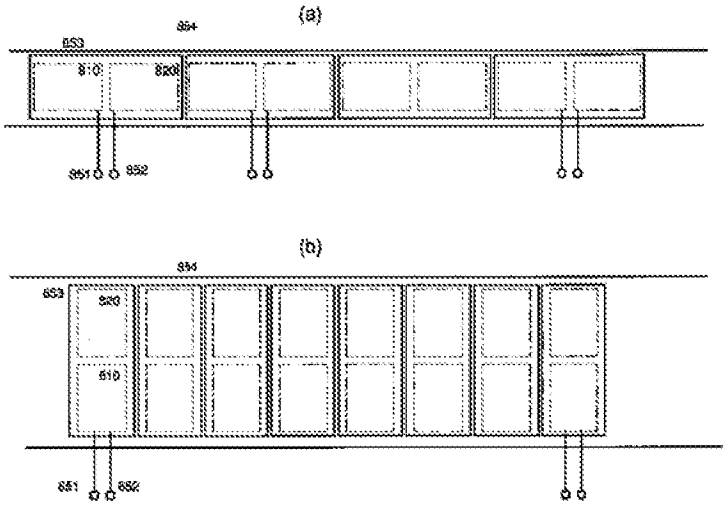
[FIG. 28]

FIG. 28



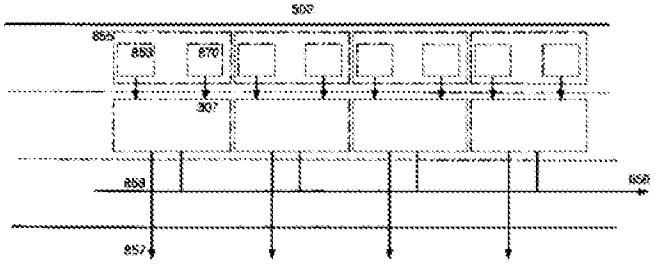
[FIG. 27]

FIG. 27



[FIG. 31]

FIG. 31



Continuation of front page

(58) Fields searched (Int.Cl.[7], DB name)
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(56)参考文献　特開　平６－201349（ＪＰ，Ａ）
特開　平３－63507（ＪＰ，Ａ）

最終頁に続く

(54)【発明の名称】　表面形状検出装置およびその方法

(57)【特許請求の範囲】

【請求項１】対象物に対してテクスチャパターンを投影する照明手段と、該照明手段で投影したテクスチャパターンを検出して光電変換手段により画像信号に変換する検出手段と、焦点位置を変化させるように制御する焦点位置制御手段と、該焦点位置制御手段により焦点位置を変化させながら前記検出手段で複数のテクスチャパターンの画像信号を検出して記憶し、該記憶した複数のテクスチャパターンの画像信号を前記対象物の表面の影響による変形分を補正して処理することにより立体形状を算出する立体形状算出手段とを備えたことを特徴とする表面形状検出装置。

【請求項２】前記対象物の表面の影響による変形分の補正が、反射および表面のレンズ効果による検出位置の変動を補正することであることを特徴とする請求項１記載の表面形状検出装置。

【請求項３】前記立体形状算出手段として、微分オペレータを用いオペレータサイズを動的に変化させて複数のテクスチャパターンの画像信号に対してコントラストを算出するコントラスト算出手段を有することを特徴とする請求項１記載の表面形状検出装置。

【請求項４】前記照明手段は開口数（Ｎ.Ａ.）の大きな光学系を有して焦点深度の小さなテクスチャパターンを投影するように構成し、前記検出手段は前記照明手段により投影されたテクスチャパターンの位置に焦点が合うように構成された開口数の大きな光学系を有し、前記焦点位置制御手段は前記照明手段の光学系の焦点位置と検出手段の光学系の焦点位置とが重なるように焦点位置を変化させるように構成したことを特徴とする請求項１記載の表面形状検出装置。

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【請求項５】前記検出手段の光電変換手段は、隣接する複数の素子の電極を互いに電荷が打ち消される方向に結合して形成したことを特徴とする請求項１記載の表面形状検出装置。

【請求項６】対象物に対してテクスチャパターンを照明して投影し、該投影したテクスチャパターンを焦点位置を制御して変化させながら検出して光電変換手段により複数のテクスチャパターンの画像信号に変換して検出し、該検出された複数のテクスチャパターンの画像信号を前記対象物の表面の影響による変形分を補正して処理することにより立体形状を算出することを特徴とする表面形状検出方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、工業製品の生産、物体移動時の外観形状の認識、あるいは認識した結果に基づいた検査をするに際し、検出した画像信号から立体形状を有する対象物の表面形状を検出する表面形状検出装置およびその方法に関する。

【０００２】

【従来の技術】従来から検出した画像から立体形状を再現する方法は数多く報告されている。特開平３－６３５０７号公報には、対象物にテクスチャパターンを投影し、焦点位置を変えながら焦点位置が異なる複数の画像を検出し、検出した像のコントラストの変化から対象物の表面形状を測定する方法が開示されている。

【０００３】また、小笠原著、「人工視覚における運動視差の機能レベル模倣」（電子情報通信学会論文誌、Ｄ－ＩＩ　Ｖｏｌ．Ｊ７４－Ｄ－ＩＩ　Ｎｏ．７　ｐｐ．９３３－９４４）には、視点の移動による立体形状の検出方法が開示されている。

【０００４】また、Adiv G.:"Determining three-demensional motion and structure fromoptical flow generated by sevral moving objects",IEEE Trans. Pattern Anal. &Mach. Intell., PAMI-7, 4, pp. 384-401(1985)には、オプティカルフローを用いた方法が提案されている。

【０００５】

【発明が解決しようとする課題】しかしながら、特開平３－６３５０７号公報によって、焦点位置の異なる複数の画像から任意の対象物の立体形状を高速に検出できるが、表面にテックスチャを持たない鏡面あるいは滑らかな拡散面を有する対象物、表面テクスチャのコントラストが薄い対象物、奥行方向に深い対象物、表面テクスチャの形状やコントラストが変化する表面を有する対象物の立体形状を検出することはできない。

【０００６】一方、小笠原著、「人工視覚における運動視差の機能レベル模倣」（電子情報通信学会論文誌、Ｄ－ＩＩ　Ｖｏｌ．Ｊ７４－Ｄ－ＩＩ　Ｎｏ．７　ｐｐ．９３３－９４４）によっても、エッヂの強調された対象物の立体形状を検出することはできても、表面にテックスチャを持たない鏡面あるいは滑らかな拡散面を有する対象物、表面テクスチャのコントラストが薄い対象物、表面テクスチャの形状やコントラストが変化する表面を有する対象物の立体形状を検出することはできない。また、エッヂの強調された対象物の立体形状は検出できるとは言っても、エッヂ追跡等の時間を要する演算処理が必要になり、さらに、クラス化、セグメンテイション等、高度でノイズに弱い演算処理が必要になる。

【０００７】また、一方でオプティカルフローを用いた方法は、微分連属性が必要条件であるため、ＴＶカメラ等を用いた方法では、急峻なエッヂ部で微分連属性が保てず、立体形状を検出できないという問題があった。

【０００８】本発明の目的は、これらの課題を解決して、表面にテックスチャを持たない鏡面あるいは滑らかな拡散面を有する対象物、表面テクスチャのコントラストが薄い対象物、表面テクスチャの形状やコントラストが変化する表面を有する対象物の表面形状、立体形状を高速で検出できる表面形状検出装置およびその方法を提供することにある。

【０００９】

【課題を解決するための手段】本発明は、上記目的を達成するために、対象物に対してテクスチャパターンを投影する照明手段と、該照明手段で投影したテクスチャパターンを検出して光電変換手段により画像信号に変換する検出手段と、焦点位置を変化させるように制御する焦点位置制御手段と、該焦点位置制御手段により焦点位置を変化させながら前記検出手段で複数のテクスチャパターンの画像信号を検出して記憶し、該記憶した複数のテクスチャパターンの画像信号を前記対象物の表面の影響による変形分を補正して処理することにより立体形状を算出する立体形状算出手段とを備えたことを特徴とする表面形状検出装置およびその方法である。即ち、本発明は、表面にテックスチャを持たない鏡面あるいは滑らかな拡散面を有する対象物、表面テクスチャのコントラストが薄い対象物、表面テクスチャの形状やコントラストが変化する表面を有する対象物の表面形状を検出するために、対象物に対してテクスチャパターンを投影する照明手段と、該照明手段で投影したテクスチャパターンを光電変換手段で受光して画像信号として検出する検出手段と、前記照明手段でテクスチャパターンを投影する際あるいは前記検出手段で検出する際に焦点位置を変化させる焦点位置変化手段と、該焦点位置変化手段で焦点位置を変化させながら前記検出手段で複数の画像を検出して記憶し、該記憶した画像信号を前記対象物の表面の影響による変形分を補正して処理することにより立体形状を算出する算出手段より構成される。

【００１０】より具体的には、本発明は、表面にテックスチャを持たない鏡面を有する対象物の形状検出は、表面付近にテクスチャパターンを投影し、これを焦点を変

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えながら、複数の画像として検出し、反射および表面のレンズ効果による検出位置の変動を補正することによって達成される。

【００１１】また本発明は、表面にテックスチャを持たない滑らかな拡散面を有する対象物あるいは表面テクスチャのコントラストが薄い対象物の形状検出は、開口数（N.A.）の小さな光学系を有する照明光学系により焦点深度の大きなテクスチャパターンを投影し、開口数の大きな光学系を有する検出光学系により焦点位置の異なる複数の画像を検出し、検出した画像からコントラスト変化を算出し表面形状を算出するか、または、開口数の大きな光学系を有する照明光学系により焦点深度の小さなテクスチャパターンを投影時の焦点位置を変化させながら投影し、開口数の小さな光学系を有する検出光学系により画像を検出し、検出した画像からコントラスト変化を算出し表面形状を算出するか、または、開口数の大きな光学系を有する照明光学系により焦点深度の小さなテクスチャパターンを投影時の焦点位置を変化させながら投影し、同時に開口数の大きな光学系を有する検出光学系の焦点位置を照明光学系の焦点位置と同じになるように同期させながら変化させながら画像を検出し、検出した画像からコントラスト変化を算出し表面形状を算出することによって達成される。

【００１２】また本発明は、表面テクスチャの形状（ピッチあるいはコントラスト）やコントラストが変化する表面を有する対象物の形状検出は、コントラスト算出時の微分オペレータのサイズを動的に変化させコントラストの算出時のＳ／Ｎを最大にする演算処理により達成される。あるいは、開口数の大きな投影光学系により、検出し算出される際のコントラストが十分大きくなるようなテクスチャパターンを投影することによって達成される。

【００１３】また、本発明は、表面テクスチャの形状（ピッチあるいはコントラスト）やコントラストが変化する表面を有する対象物の形状検出はまた、コントラストと言う概念を用いずに検出した濃淡画像を平面方向に微分し、微分して得られた画像の各同一座標位置で微分値が最大値になる焦点位置を算出することで形状が算出される。

【００１４】また、本発明は、表面テクスチャの形状やコントラストが変化する表面を有する対象物の形状検出は、対象物を検出器上に結像する光学系と、結像した像を光学系の結像分解能より高い分解能を持つ検出器で検出する手段と、画像を検出する際画像を検出する位置あるいは検出の方向を変化させる（視点の位置を移動させる）手段と、空間変化率が十分大きくなるように空間的に十分な移動量が確保できるまでの間次のサンプリングまでの時間を（空間変化率算出の為のサンプリング時間を）大きく取り、またエッジ部のような急峻な部分では空間変化率が無限大にならないように、換言すれば算出可能な程度にサンプリング時間を小さく取るようサンプリング時間をコントロールして上記条件を変化させて検出器から得られる画像信号より光強度の空間変化率と時間変化率を算出し、該算出された空間変化率および時間変化率から視点の移動に対する検出位置の変化である速度を算出し、該算出された速度に基づいて対象物の表面形状を算出する算出手段とを備えたことを特徴とする。

【００１５】また、本発明は、対象物の２次元的な画像を検出する際、検出器のコントラストを大きくすることにより達成される。

【００１６】

【作用】表面にテックスチャを持たない鏡面あるいは滑らかな拡散面を有する対象物、表面テクスチャのコントラストが薄い対象物、表面テクスチャの形状やコントラストが変化する表面を有する対象物の表面形状を検出するために、対象物に対してテクスチャパターンを投影する手段、投影したテクスチャパターンを検出する手段、テクスチャパクーンを投影する際あるいは検出する際に焦点位置を変化させる手段、焦点位置を変化させながら複数の画像を検出、記憶する手段、検出、記憶した信号を処理し上記目標の立体形状を算出する手段より構成される。

【００１７】表面にテックスチャを持たない鏡面を有する対象物の形状検出方法の作用について説明する。

【００１８】表面にテクスチャを持たない鏡面状の平面の焦点位置を検出する方法が特開昭６１－１２４８０９号公報に開示されている。この方法は平面上にパターンを投影しこのコントラスト変化から焦点位置を検出するものであるが、任意の立体形状を有する鏡面の形状検出はこの方法ではできない。しかしながら、鏡面状の表面にパターンを投影すると言う思想は、本課題の解決に利用できるということに着目した。即ち、表面にテクスチャを持たない鏡面を有する対象物の形状を測定するに当たって、表面付近にテクスチャパターンを投影し、これを焦点を変えながら、複数の画像として検出すればコントラストの変化は算出できる。さらにこのようにして算出されたコントラストから、特開平３－６３５０７号公報に開示されている方法により何らかの形状を算出することができるが、このようにして算出された形状には、反射および表面のレンズ効果による検出位置の変動が含まれていることを考慮しなければいけない。この補正方法について説明する。

【００１９】表面にテックスチャを持たない鏡面を有する対象物にテクスチャパターンを投影すると、テクスチャパターンは対象物に反射して対象物の対称な位置にあるように観察される。さらに、対象物の表面の凹凸構造のレンズ効果により変換された位置にあるように観察される。従って、焦点位置を変えて画像を検出し対象物表面の形状を測定すると実際の形状と異なった形状が測定される。そこで、真の形状を知るには、この反射の効果

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とレンズ効果による変形分を補正する必要がある。反射の効果とレンズ効果で変形した形状，即ち検出される形状をΔｚ(x,y)とすると，真の形状をΔｚ０(x,y)は，以下の式（数１），（数２）で示される。

【００２０】

$$1/a(\Delta z(x,y),\ a0)+1/b=1/f(F,\ R(x,y)) \qquad (数1)$$

$$R(x,y)=k\cdot\mathrm{grad}(\Delta z0(x,y)) \qquad (数2)$$

ここで、検出光学系の一次側主平面から対象物までの距離ａ（Δｚ(ｘ,ｙ),ａ０）は，真の形状Δｚ０(ｘ,ｙ)によるレンズ効果により補正されるため、真の形状Δｚ０(ｘ,ｙ)およびレンズ効果がない場合の一次側主平面から対象物までの距離ａ０の関数である。

【００２１】検出される形状Δｚ(x,y)をもとに，上記式（数１）（数２）を用いて補正することによって、真の形状Δｚ０(x,y)が測定（算出）することができる。

【００２２】表面にテックスチャを持たない滑らかな拡散面を有する対象物の形状検出方法の作用について説明する。このような対象物では表面にテクスチャを投影する必要がある。表面にテクスチャパターンを投影する方法は特開平３－６３５０７号公報にも開示されているが、光学系の焦点深度と解像度については言及されていない。ところが、テクスチャパターンの投影の際には光学系の焦点深度と解像度を考慮する必要がある。表面が滑らかな拡散面でありかつ形状が高さ方向に深い場合、このような対称物にテクスチャパターンを投影するには、焦点深度の大きい光学系が必要になる。ところが、焦点深度の大きな光学系は、開口数が小さい必要があり、開口数の小さい光学系は解像度が小さく，微細なテクスチャパターンを投影できない。即ち、テクスチャパターンの検出の際、平面方向に十分な分解能を持ち、光軸方向に焦点深度の深い光学系は実現できないことになる。解像度ｄは、開口数をN.A.(Numerical Aperture)，使用波長をλとすると以下の式（数３）で示される。

【００２３】

$$d=1.22\cdot\lambda/N.A. \qquad (数3)$$

一方，焦点深度±ｈは、以下の式（数４）で示される。

【００２４】

$$h=0.5\cdot\lambda/(N.A.)^2 \qquad (数4)$$

図１０に，上記の式（数３）（数４）で算出した光学系の開口数N.A.と開口数N.A.に対する焦点深度ｈおよび分解能（解像度）ｄを示す。図１０では、波長を0.5ミクロンとして算出した結果を示す。

【００２５】この図１０から，例えば，照明光学系の開口数N.A.を0.008付近にとれば、分解能ｄは７６ミクロン程度，焦点深度±ｈは３．９ｍｍ程度になる。ここで，検出光学系の開口数N.A.を0.04程度にとれば，焦点深度±ｈは１５６ミクロン程度検出時の平面方向の分解能ｄは10ミクロン程度になる。ここで、特開平３－６３５０７号公報には、検出系の焦点深度±ｈを変化させる構成が開示されているが、とくに、滑らかな拡散面を有する対象物の場合は，照明系の焦点深度±ｈを小さくして照明系の焦点位置を変化させてもよいことがわかる。すなわち、照明系の開口数N.A.を0.03程度にとり、100ミクロン程度のテクスチャパターンを投影する。照明系の分解能ｄは２０ミクロン程度であるから、テクスチャパターンは高解像度で投影される。この際、検出光学系の開口数N.A.を0.006程度にとれば，分解能ｄは100ミクロン程度になり、また焦点深度±ｈは，７ｍｍを確保できる。従って，滑らかな拡散面を有する対象物の立体形状を検出することができる。

【００２６】さらに，例えば、高さ方向１ｍｍ程度の表面テクスチャをもたない対象物を１０ミクロン程度の平面分解能で検出したい場合，図１０より投影光学系も検出光学系も適切なものが存在しないことがわかる。このような場合，照明光学系も検出光学系も開口数N.A.を0.1程度にして、６ミクロンの分解能ｄを確保する。さらに、照明光学系の焦点位置と検出光学系の焦点位置を同期させながら複数の画像を検出し、コントラスト変化から平面形状を検出することができる。この構成により、光学系の焦点深度より高さ方向に高い対象物に対しても立体形状を検出することができる。また，鏡面状の対象物の形状を検出する際には、照明光学系の焦点深度を浅くする必要があるため、このような検出光学系と照明光学系の焦点を同期させる構成は有効である。

【００２７】表面テクスチャの形状（ピッチあるいはコントラスト）やコントラストが変化する表面を有する対象物の形状検出方法の作用について説明する。コントラスト算出時には、とくに表面のテクスチャによる光の強度変化が緩やかな場合，変化の緩やかな範囲でコントラストを算出すると現実的には、微分によるノイズの増加によりコントラストを算出できない場合がある。そこで、微分オペレータのサイズを動的に変化させコントラストの値が十分大きくなるようにあるいは算出時のＳ／Ｎを最大にする様なオペレータによる演算処理によりコントラストを高精度で算出できるようになる。あるいは、滑らかな拡散面を有する対象物に対するように適切なテクスチャを投影することによって、拡散面を有する対象物の検出方法と同様の作用により、高精度でコントラストを算出できる。

【００２８】また、平面方向にコントラストが変化するようなテクスチャを持つ対象物、あるいは投影したテクスチャのコントラストが変化するような場合，特開平３－６５３０７号公報の方法では、コントラストを算出する微分オペレータのサイズを適切な値にしないとコント

ラストを算出できない。しかしながら、本発明の構成では、各座標位置毎に各焦点位置毎に算出した微分値の変化量から微分値の極大値を算出するため、コントラストが平面内で変化するような対象物、テクスチャパターンの周期が変化するような対象物の立体形状を算出することができる。

【００２９】また、表面テクスチャの形状やコントラストが変化する表面を有する対象物の形状検出は、対象物を検出器上に結像する光学系と、結像した像を光学系の結像分解能より高い分解能を持つ検出器で検出する手段と、画像を検出する際画像を検出する位置あるいは検出の方向を変化させる手段と、上記条件を変化させて取得した画像より光強度の空間変化率と時間変化率を算出する手段と、該空間変化率および時間変化率の算出に当たっては空間変化率が十分大きくなるように空間的に十分な移動量が確保できるまでの間次のサンプリングまでの時間を（空間変化率算出の為のサンプリング時間を）大きく取り、またエッジ部のような急峻な部分では空間変化率が無限大にならないように、換言すれば算出可能な程度にサンプリング時間を小さく取るようサンプリング時間をコントロールする手段と、該空間変化率及び時間変化率から角速度を算出する手段とにより解決される。

【００３０】焦点位置を変えながらコントラストの変化を算出する特開平３－６３５０７号公報では、テクスチャパターンの空間的周期が検出光学系の分解能より十分大きい対物物の場合、焦点位置の変化ではコントラストが変化しないため、コントラスト変化を検出するのは難しい。これに対し本発明の上記構成では、検出器の位置を変えながらコントラストの変化を算出するのでコントラスト変化を得ることができる。

【００３１】また、上記課題は対象物の２次元的な画像を検出する際、検出器のコントラストを大きくすることにより達成される。

【００３２】

【実施例】図１１に、本発明の一実施例を示す。本発明は、光源４０１、拡散板４０２、テクスチャパターン４０３、ハーフミラー４０４より構成される照明光学系４００、検出レンズ５０１、検出器５０２より構成される検出光学系５００、微分回路５０１、フレームメモリ５０２、５０３、５０４、ピーク検出回路５０５、フレームメモリ５０６より構成される信号処理系５００より構成される。

【００３３】照明光学系４００では、光源４０１によりテクスチャパターン４０３を照明しハーフミラー４０４および検出レンズ５０１を通し対象物１の近傍４に結像する。検出光学系５００では、近傍４に結像されたテクスチャパターン４０３の像を検出レンズ５０１により検出器５０２上に結像する。

【００３４】例えば図１２に示した対象物７に対し、焦点位置を１３、１４、１５と変えた位置で検出された複数の画像（光強度）を図１３の８、９、１０にそれぞれ示す。それぞれ検出された画像信号は微分回路６０１により微分され、図１４の１６、１７、１８のようコントラストが算出される。この微分結果即ちコントラストが、フレームメモリ６０２、６０３、６０４に取り込み格納される。フレームメモリ６０２、６０３、６０４に取り込み格納された複数の画像から各座標位置毎に微分値が最大となる焦点位置を算出手段６０５により算出する。例えば座標位置１９のときの例を示す。この座標位置１９での各画像でのコントラストはそれぞれ２０、２１、２２である。このコントラスト２０、２１、２２を図１５に、横軸を焦点位置として示す。この図１５を内挿してコントラスト極大値を算出手段６０５により算出する。この極大値の算出の際、特開平３－６３５０７号公報には、ガウシャン分布を仮定して極大値を算出する方法が開示されているが、必ずしもガウシャン分布を仮定する必要はなく、２次曲線の近似であってもよい。この場合、コントラストの極大値は図１５の如く２次曲線で内挿することにより算出される。この際、算出結果が結果的に内挿により算出されるのが望ましい。また、図１５の如く算出しても実質的に問題なく、かつ演算処理が容易であるという利点を有する。

【００３５】焦点位置、即ち対象物の高さ情報として算出された結果はフレームメモリ６０６に格納される。

【００３６】前記の如く算出手段６０５で算出された極大値がフレームメモリ６０６に格納され、焦点位置、即ち対象物の高さ情報から形成された対象物表面の立体形状になる。ここで、極大値が存在しない場合は、この範囲のなかに焦点が合った個所が無いことになり位置が検出されなかったことになる。このような場合は予め設定されたエラー信号をフレームメモリ６０６に格納すればよい。ここでは、３枚の画像データのコントラストから各座標位置のコントラストを算出したが、用いる画像データの数は３枚である必要はなく複数の画像であればよい。もちろんより多くの画像を用いることでＳ／Ｎを向上できるのは言うまでもない。

【００３７】以下、本発明の動作を説明する。対象物１が鏡面に近い場合テクスチャパターン４０３の像は対象物１に反射して位置３にあるように観察される。さらに、対象物の表面の凹凸構造のレンズ効果により位置２にあるように観察される。従って、焦点位置を変えて画像を検出し対象物表面の形状を測定すると２の形状が測定される。この形状には反射の効果とレンズ効果により変形されたものとなっている。そこで、真の形状１を知るには、この反射の効果とレンズ効果による変形分を補正する必要がある。反射の効果とレンズ効果で変形した形状、即ち検出される形状を$\Delta z(x,y)$とすると、真の形状を$\Delta z0(x,y)$は、前記した式（数１）（数２）で示される。

【００３８】位置２にあるように観察される像は検出器

５０２により検出され微分処理回路６０１により微分処理が施されフレームメモリ６０２、６０３、６０４に格納される。この微分処理は、検出した画像のコントラストを算出するためのものであって、例えば、３（ｘ方向の画素サイズ）／３（ｙ方向の画素サイズ）の範囲に対して２次微分を施すことによって達成される。あるいは、５×５などより大きな範囲の２次微分であってもよく、２次微分以外のラプラシアン、ガウシャンラプラシアン、１次微分など各種の微分オペレータであってよい。

【００３９】ここで、コントラストの算出にあたっては、オペレータサイズをテクスチャのピッチＰに合わせると算出のＳ／Ｎが向上する。従って、テクスチャパターンを照射するような場合は、テクスチャパターンのピッチにオペレータサイズを合わせてコントラストを算出するとよい。

【００４０】図１３ではコントラストを微分処理回路６０１により微分を用いて算出しているが、コントラストを算出するに当たって、テクスチャパターンの強度変化のコントラストで算出してもよい。具体的には、図１３の検出波形の隣り合う極大値ＭＡＸとＭＩＮを用いるとコントラトＣは以下の式（数５）で示される。

【００４１】

$$C=(MAX-MIN)/(MAX+MIN) \qquad (数5)$$

この式（数５）によって、上記のコントラストＣを算出してもよい。この式（数５）を用いると検出波形の強度変化が小さいような場合であっても光感度でコントラストを算出できると言う効果がある。しかし、一方で極大値、極小値を算出する必要が出てきて、演算処理が増加する。この演算処理を減らすために強度変化の周期、即ちテクスチャの空間的な周期に合わせて信号を取り込むようにすればよい。この実現のためには、テクスチャパターンの周期が一定である必要がある。あるいは、テクスチャパターンの周期を場所毎に算出してその結果で、式（数５）のコントラスト算出を実施すればよい。

【００４２】また、鏡面とは言っても実際には表面に小さな傷、異物あるいは凹凸が存在するためこれらを検出してこれらの検出像のコントラスト変化から立体形状を検出することができる。また、表面に解像度の１０倍程度の大きさの凹凸がある場合、この凹凸を検出して検出された凹凸のコントラスト変化から表面形状を検出することができる。この場合、表面にある凹凸なのか表面で反射してくる背景光なのかを分ける必要がある。このためには無限遠から白色のインコヒーレント光を照明するのがよい。この、白色のインコヒーレント光の照射では、あらゆる方向に光が射出しているため凹凸でのレンズ効果により表面の凹凸の位置などが急激に変化する現象が起きにくいからである。が生じだからである。

【００４３】以上の実施例では、対象物１により反射した像を検出しているため、反射した像の光束がレンズの開口に入射する必要がある。急峻な形状の対象物の場合、反射した像の光束がレンズの開口に入射しないため、急峻な形状を検出することは難しい。そこで、このような急峻な形状の対象物を検出するための構成を図１６に示す。

【００４４】図１６に示した実施例は、図１１に示した構成のなかの照明光学系４００と同様な複数の照明光学系４０５、４０６、４０７、４０８、検出光学系５００により構成される。この複数の照明光学系４０５、４０６、４０７、４０８は、それぞれ異なる波長を照射できるようにそれぞれ異なる色フィルターを有している、検出光学系５００ではそれぞれの色を検出する検出器５０２、５０３、５０４、５０５によりそれぞれの照明方向からの光が検出される。

【００４５】ここで、それぞれの方向からの光を独立に検出する手段として、図１６に示す実施例では異なる波長の光を照射し、これを分離する構成としたが、本発明の効果を得るためにはこのような構成である必要はなく、例えば、各照明の方向から順次照明し、各タイミングで検出光学系５００が信号を検出する構成であってもよく、図１８に示すように、照明光学系４００と検出光学系５００を合わせ持つ構成の光学系を有し、この光学系を対象物１に対する角度を変えながら各角度での信号を検出する構成であってもよい。ここで、図１６のような構成で検出した各方向からの検出像を図１７（ａ）、（ｂ）、（ｃ）に示す。このような画像を各波長毎にテクスチャパターンの投影位置を変えながら検出し、各波長毎に信号処理系６０７、６０８、６０９、６１０により形状が算出される。ここで、それぞれの算出された形状は各照明光学系の方向から照明された場合の検出形状であるから、方向補正回路６１１により補正され、フレームメモリ６１２に格納される。ハッチングを施した個所が各方向からの検出信号のコントラストがある値以上になった部分を示す。具体的には、このハッチング以外の部分からは光が反射しなかったということを示す。対象物１によっては、照明系が２本で十分の場合もあり、４から５本必要になる場合もある。いずれにせよ、視野全面が必要に応じて網羅されていなければならない。この様な構成によって急峻な形状の鏡面を有する対象物の形状を測定することができる。

【００４６】図１９に、表面にテクスチャを持たない滑らかな深い拡散面を有する対象物１の表面形状を検出する実施例を示す。この実施例は図１１の実施例と同様の照明光学系４００、対物レンズ駆動機構５０９を有する図１１の実施例と同様の検出光学系５００、第１図の構成と同様の信号処理系４００より構成される。この実施例では、テクスチャパターン４０３がハーフミラー４０４、対物レンズ５０１を通して対象物１の近傍１３に投

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影される。この投影されたパターンに焦点が合うように検出光学系５００は設定されている。ここで、パターンの投影位置を位置１３から位置１４に変えるために、対物レンズ駆動系５０９により対物レンズ５０１を光軸方向に駆動する。この構成により、照明光学系４００が対象物１の全ての面に焦点を合わせてテクスチャパターンを投影できないような光軸方向に深い対象物に対しても、焦点を合わせてテクスチャパターンを投影することができる。ここで、この実施例では、投影時の焦点位置を変えることができるので、深い焦点深度を有する照明光学系を用いる必要がない、結果的に焦点深度の浅い言い換えれば結像解像度の高い照明系を用いることができ、高い解像度でテクスチャパターンを投影できるため、立体形状の検出分解能を向上できる。

【００４７】図１０に、前記式（数３）（数４）で算出した一般的な光学系の開口数と開口数に対する焦点深度および分解能を示す。照明光学系４００の開口数N.A.を0.008付近にとれば、分解能ｄは７６ミクロン程度、焦点深度±ｈは３．９ｍｍ程度になる。ここで、検出光学系５００の開口数N.A.を0.04程度にとれば、焦点深度±ｈは１５６ミクロン程度検出時の平面方向の分解能ｄは10ミクロン程度になる。ここで、特開平３－６３５０７号公報には、検出系の焦点深度±ｈを変化させる構成が開示されているが、とくに、滑らかな拡散面を有する対象物の場合は、照明系の焦点深度±ｈを小さくして照明系の焦点位置を変化させてもよいことがわかる。すなわち、照明系４００の開口数N.A.を0.03程度にとり、100ミクロン程度のテクスチャパターンを投影する。照明系４００の分解能ｄは２０ミクロン程度であるから、テクスチャパターンは高解像度で投影される。この際、検出光学系５００の開口数N.A.を0.006程度にとれば、分解能ｄは100ミクロン程度になり、また焦点深度±ｈは、７ｍｍを確保できる。従って、滑らかな拡散面を有する対象物１の立体形状を検出することができる。

【００４８】さらに、例えば、高さ方向１ｍｍ程度の表面テクスチャをもたない対象物１を１０ミクロン程度の平面分解能で検出したい場合、図１０より投影光学系も検出光学系も適切なものが存在しないことがわかる。このような場合、照明光学系４００も検出光学系５００も開口数N.A.を0.1程度にして、６ミクロンの分解能ｄを確保する。さらに、照明光学系４００の焦点位置と検出光学系５００の焦点位置を同期させながら複数の画像を検出し、コントラスト変化から平面形状を検出することができる。この構成により、光学系の焦点深度より高さ方向に高い対象物に対しても立体形状を検出することができる。また、鏡面状の対象物の形状を検出する際には、照明光学系４００の焦点深度を浅くする必要があるため、このような検出光学系５００と照明光学系４００の焦点を同期させる構成は有効である。

【００４９】以下に本発明の立体形状検出装置の具体的実施例を図１から図２を用いて説明する。本実施例は、光源１０１、スリット１０２、ハーフミラー１０３、照明レンズ１０４、拡散板１０６より構成される照明系１００、物レンズ２０１、リレーレンズ２０２、結像レンズ２０３、検出器２０４、空間フィルター２０５、空間フィルター制御系２０６、倍率可変機構２０８、焦点機構２０９より構成される検出光学系２００、平滑回路３０１、メモリ３０２、３０３、３０４、時間微分回路３０５、空間微分回路３０６、速度検出回路３０７、初速度検出回路３０８、隠線処理回路３０９、積分回路３１０、速度メモリ３１１より構成される信号処理系３００より構成される。

【００５０】照明系１００では、光源１０１により格子形状、水玉もよう、ランダムパターン、スペックルもよう等のもようを持つスリットが照明される。このスリット１０２は照明レンズ１０４により対象物１上に結像される。ここで、拡散板１０６をスリット１０２の直前に設けることで、光源の照度ムラに対応することができる。光源１０１は通常の白色フィラメント灯でよいが、その他の光源、すなわち蛍光灯、ハロゲンランプ、水銀灯、キセノンランプ等であってよい。さらに、赤外線ランプあるいは紫外線ランプ等、あるいは半導体レーザ、Ａｒレーザ、Ｈｅ－Ｎｅレーザなどのレーザ光源であってもよい。

【００５１】また、ここでは照明レンズ１０４として対物レンズ２０１を併用しているが、照明レンズ１０４は、図２に示すように検出光学系２００から切り放されたものであってもよく、また、太陽、月等からの自然光であってもよい。

【００５２】検出系２００では、対象物１から射出する光を対物レンズ２０１、リレーレンズ２０２、結像レンズ２０３により検出器（光電変換手段）２０４に導き対象物１の２次元画像を検出器２０４上に結像する。この光学系内には、空間フィルター２０５が挿入されている。この空間フィルター２０５は対象物１の光学系によるフーリエ変換の位置に設定されるのが最良であるが、対物レンズ２０１の直前あるいは直後、あるいは結像レンズの直前、直後あるいは対物レンズの焦点位置であってよい。空間フィルター２０５は図３に示すように円形の開口２０７を有し、空間フィルター制御系２０６により、開口２０７の半径ｒ、位置ｘ、ｙが制御され、対象物１上の点に対する検出位置または検出方向θが変化（移動）するように制御される。この際の制御方法は、液晶表示素子を用いても、あるいは虹彩絞りによりｒを制御しＸＹステージによりｘ，ｙを制御してもよい。この開口２０７は、ここでは円形のものを用いているが、必ずしも円形である必要はなく、正方形、長方形、楕円、あるいはその他の形状であってよい。また、検出系２００は、倍率可変機構２０８により、検出器２０４に結像される結像倍率を変化させ、対象物１上の点に対す

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る検出位置または検出方向δが変化（移動）するように制御することができる。この倍率可変により、検出器上に結像される像の分解能を検出器の画素サイズより大きくするという本発明の技術的目的も達成することができる。同時に、この機構により、対象物の一部を拡大して検出できるという効果を達成できる。また、検出系２００は焦点機構２０９を有していて、対象物１の像を検出器２０４上（検出器２０４上の座標ｘ）に結像するようになっている。

【００５３】ここで、開口２０７を等速で操作することによって、結果的に、対象物１を見る視点の位置δが移動し、座標ｘを有する検出器（光電変換手段）２０４上に結像される画像の位置を変化させることができる。この操作によって、図９により後に説明するような視点の位置δの移動（検出位置または検出方向を変化させること）が可能である。ここで、検出器２０４の画素サイズｗは、対物レンズ２０１、リレーレンズ２０２、結像レンズ２０３から構成された結像光学系の分解能より小さく設定され、検出器（光電変換手段）２０４から出力される画像信号が連続した光強度変化として得られるように構成している。また、検出器２０４のダイナミックレンジは、後に説明する値より大きく設定されている。

【００５４】検出器２０４は１次元のセンサでも２次元のセンサでも良いことは言うまでもない。

【００５５】信号処理系３００では、平滑回路３０１を通過した信号はメモリ３０２、３０３を有する信号伝達経路、メモリ３０４を有する信号伝達経路、メモリを有しない信号伝達経路に分岐される。平滑回路３０１は、検出信号の高周波ノイズ（急峻な画像信号）を除去して画像信号の強度変化が位置座標で微分可能な程度に緩やかに変化させるものであって、ノイズ（急峻な画像信号）が問題にならないときは省くことができる。それぞれのメモリはいずれもいわゆるフレームメモリであり、１フレーム分の画像情報ｉを記憶しておく。この結果メモリ３０４を通過後の情報は平滑回路３０１通過後の情報の１フレーム前のものであり、メモリ３０３通過後の情報はメモリ３０４通過後の情報の１フレーム前のものである。この、３つの情報より時間微分回路３０５により、フレームメモリ内の各位置座標毎に、画像信号（検出像の光強度分布）ｉを時間微分（ｄｉ／ｄｔ）される。同時に平滑回路３０１からの信号ｉは、空間微分回路３０６により空間的に微分（ｄｉ／ｄｘ）され、その逆数（ｄｘ／ｄｉ）が出力される。これらの微分回路３０８、３０６から出力される信号（ｄｉ／ｄｔ）、（ｄｘ／ｄｉ）に基づいて後述する式（数７）により速度検出回路３０７により速度（ｄｘ／ｄδ）が検出される。なお、後述する視点の位置δの移動速度（ｄδ／ｄｔ）は等速度運動にすれば、定数となり、予め設定することもでき、等速度にしないとしても、予め空間フィルター制御系２０６または倍率可変機構２０８によって所望のプロファイルとして設定することもでき、また測定手段を備えて空間フィルター制御系２０６によって制御される開口２０７による移動速度、または倍率可変機構２０８によって可変される結像倍率による移動速度を測定して算出することもできる。

【００５６】前記の如く検出された速度（ｄｘ／ｄδ））より初速度検出回路３０８で各点での初速度（ｔ０のときの速度（ｄｘ／ｄδ））が算出される。この後、隠線処理回路３０９により隠線処理が施され、積分回路で各時間タイミングで出力される信号が積分され、速度メモリ３１１に記憶される。速度メモリ３１１内の情報は後述する式（数６）の関係から高さ情報ｚに変換される。

【００５７】以下、本発明の動作について説明する。対象物１に光源１０１から射出された光が照明される。対象物１からはその形状に応じて照明された光が様々な方向に射出する。この際、射出する光は、対象物１の表面状態に応じて、回折し、散乱し、反射し、また多くの場合、これらの現象が複合された形で射出する。ここで、対象物１が図４に示す形状をしている場合、表面の凹凸形状、あるいは表面の反射率分布、表面の微細形状により、射出光の強度は、各点で各射出方向ごとに分布を持つ。その結果、射出した光により検出光学系２００を通して検出器２０４上に結像し、座標ｘを有する検出器２０４を通過し、平滑回路３０１通過後の信号は図５に示すような強度分布ｉを持つ。

【００５８】この信号（光強度）ｉを空間微分回路３０５によって検出位置ｘに対して微分した信号（ｄｉ／ｄｘ）が図６に示した信号である。また、時間微分回路３０５によって微分した信号（ｄｉ／ｄｔ）が図７に示した信号である。さらに、後述する式（数７）に基づいて速度検出回路３０７によって、速度（ｄｘ／ｄδ）が算出され、該速度に基づいて後述する式（数６）により第８図に示すような検出位置ｘに対する高さｚ情報として立体形状を検出することができる。ここで、この速度検出にあっては、以下に示す基本原理によって、算出されるわけであるが、空間微分回路３０６による信号について逆数（ｄｘ／ｄｉ）をとる必要が有り、この空間微分信号（ｄｉ／ｄｘ）が０あるいは０に近い値の時は、０割（０で割算すること）ができないため、この速度検出回路３０７で速度（ｄｘ／ｄδ）を検出することができない。そこで、空間微分回路３０６は、その微分値が０に近い値にならないように十分な距離ｘをもって微分するようになっている。即ち、結像レンズ２０３等の結像光学系の結像分解能よりも検出器２０４の検出分解能を大きくすれば空間微分値を０に近い値にならないようにすることができる。また、平滑回路３０１で検出信号の内、急峻な信号成分を取り除くのは、空間微分値を０に近い値にならないようにするためである。

【００５９】しかしながら、十分な距離ｘをもってして

も空間微分値（ｄｉ／ｄｘ）を十分大きな値にできないような信号の場合、速度検出回路３０７は「速度検出不能」という信号を出力する。前記の如く算出された速度信号（ｄｘ／ｄδ）により、後述する式（数６）により図８に示すごとく、対象物１の立体形状が算出される。

【００６０】図９に本発明の基本原理を示す。対象物１を視点Ａ及び視点Ａから微小距離離れた視点Ｂから観察した場合を示している。この場合、対象物上のＰ１、Ｐ２はそれぞれ視点ＡからのＰ１，Ｐ２の方向を基準にして、θ１、θ２の方向に移動して観察される。すなわち、対象物１は、検出器２０４上で、対象物１を視点Ａ，Ｂから仮想の平面２上に投影結像した図形として検出される。即ち、各点Ｐ１，Ｐ２がある角速度で移動したように検出器２０４で検出される。本発明は、この角

$$z = f(v) = f(dx/d\delta) \qquad (数6)$$

ここで、ｆ（ｖ）は、検出光学系（対物レンズ２０１、リレーレンズ２０２、結像レンズ２０４等）の関数である。具体的には、δが十分小さい場合には線形である。δが大きい場合、視点ＢからのＰ１，Ｐ２の見込み角θ１、θ２を基にした補正関数になる。ここでの線形係数

$$dx/d\delta = (dx/di)\cdot(di/d\delta)$$
$$= (dx/di)\cdot(di/dt)\cdot(dt/d\delta) \qquad (数7)$$

ここで変数分離の式（数７）が成立するためには、ｉは、ｘ，δ、の関数、すなわち、ｉ（ｘ，δ）であり、ｘがｉの関数であり、ｉがδの関数である必要があり、かつそれぞれが微分可能である必要がある。このような関数ｉとして，近似的に、かつ特殊な場合として，検出像の光強度分布をとることができる。ここで、ｄｘ／ｄｉは、光強度ｉを検出画像の位置座標ｘで微分した空間微分値（ｄｉ／ｄｘ）の逆数である。

【００６５】あるいは、ｉがｘの関数であり、ｄｉ／ｄｘが０にならない場合であってもよい。ここには、この問題を自然科学としてだけでなく工学としてとらえる考え方が必要である。すなわち、ｄｉ／ｄｘが０にならない状態、さらには、ｄｉ／ｄｘが無限大にならない状態（微分可能な状態）を積極的に作り出す必要がある。

【００６６】このｄｉ／ｄｘが０にならない状態を作る方法がさきに説明した空間微分回路３０６の機能である。さらに、ｄｉ／ｄｘの算出に当たっては、ｄｉが十分大きくなるようにｄｘを大きく取る必要がある。検出方向を変化させながら信号を検出する図１に示すような検出光学系の場合、サンプリング時間を十分大きく取ることによってこの条件は満たされる。具体的には，図１に示すように，空間微分回路３０６は、微分回路３１３、微分値積分回路３１４、積分値判定回路３１５により構成される。ここで、画像信号は、微分回路３１３により微分され、この結果が微分値積分回路３１４で積分される。積分値判定回路３１５によって、この積分値が０より十分大きい値かどうか判定され、０より十分大きい値になるまで微分値積分回路３１５によって積分され速度を算出することが重要である。この結果、Ｐ１の結像された投影像Ｐ１１はＰ１２に、Ｐ２の結像された投影像Ｐ２１はＰ２２に移動したように検出される。この移動量をｘ１、ｘ２（検出器２０４上の座標）とすると、対象物１の立体形状すなわち奥行きｚ１、ｚ２は、視点の移動量δに対するｘ１、ｘ２の変化率ｖ１、ｖ２の関数ｆ（ｖ１），ｆ（ｖ２）になっている。従って、観察される全ての点で移動量の変化率ｖを求めればよい。

【００６１】以上より、移動量の変化率ｖを算出すれば対象物１の立体形状が求められる。すなわち以下の式（数６）が成り立つ。

【００６２】

（数６）

等は、検出光学系等の仕様により別途設定される。

【００６３】次に式（数６）をいかにして求めるかを説明する。さらに変数分離によって以下の式（数７）が成立する。

【００６４】

$$dx/d\delta = (dx/di)\cdot(di/d\delta)$$
$$= (dx/di)\cdot(di/dt)\cdot(dt/d\delta) \qquad (数7)$$

る。

【００６７】同様に、時間微分回路３０５でも、微分回路３１６による微分値が微分値積分回路３１８によって積分される。積分値判定回路３１７によってこの積分値が０より十分大きい値かどうか判定され，０より十分大きい値になるまで微分値積分回路３１８によってさらに積分される。

【００６８】またｄｉ／ｄｘが無限大にならない状態を作る方法が、先に説明した空間微分回路３０６および検出光学系の分解能より検出器の分解能の方を高くした光学系である。検出光学系の分解能より検出器の分解能の方を高くし、ｄｉ／ｄｘ算出時のサンプリング時間中の検出像の移動距離が分解能と同程度あるいは十分小さくなるように設定することにより、エッジ部など従来の方法では微分できなかった場合であっても上記のｉの空間的微分可能性は保たれる。具体的には、検出器２０４が電荷転送型の検出器の場合，検出器の蓄積時間がサンプリング時間になる。従って、この蓄積時間中に空間フィルター２０５の移動による検出像の移動距離が先の検出光学系の分解能より小さくなるように、蓄積時間を設定する。

【００６９】以上の微分積分回路、および判定回路は、デジタル回路によって実現されてもよいし、アナログ回路によって実現されてもよい。

【００７０】また、検出光学系２００あるいは空間フィルター２０５の移動速度ｄδ／ｄｔが一定の場合，すなわち等速運動Ｖ０の場合、検出器２０４で検出された画像面上の速度（移動量ｄδに対する）ｄｘ／ｄδは式

（数７）より

$$dx/d\delta=(dx/di)\cdot(di/dt)\cdot(1/V0)$$
$$=k\cdot(dx/di)\cdot(di/dt)\qquad(数8)$$

となり、（ｄｘ／ｄｉ）、（ｄｉ／ｄｔ）は夫れ夫れ、空間微分回路３０６、時間微分回路３０５で演算可能であり、その結果速度ｄｘ／ｄδを算出することができる。ｄδ／ｄｔが等速度でない場合、式（数７）よりｄδ／ｄｔも含めて算出する必要がある。

【００７１】なお、ｄδ／ｄｔが等速度でない場合、検出光学系２００あるいは空間フィルター２０５の速度をなんらかの測定手段で測定すれば良い。また制御駆動系からのデータにより算出される速度を用いても良い。

【００７２】そして、速度算出回路３０７では、式（数７）に示した演算を実施し、各点の速度が算出される。

【００７３】以上結像光学系の分解能を、検出器２０４の分解能より低くして、検出画像を平面的（空間的）に微分可能にする手段として、光学系の分解能を光学系で悪くする方法も説明したが、他の方法であっても良い。例えば、分解能の高い光学系で取り込んだ画像信号を、平面的に平滑回路３０１で平滑化処理しても良い。一度平滑化すると、あたかも光学系の分解能が低いかのようなボケた画像信号が得られる。この際の平滑化の処理はＸ方向画素数Ｘｎ、Ｙ方向画素数ＹｎとしてＸｎ×Ｙｎの範囲のたたみ込み積分をしても良いし、フーリエ変換領域で高周波成分を遮断しても良い。

【００７４】以上の各時刻毎の結果を基に、ある時刻ｔ０のときの各点の速度（ｄｘ／ｄδ）を算出するのが初速度検出回路３０８である。このあと、隠線処理回路３０９により、各時刻ｔの時の信号の内時刻ｔ０で見えないはずの部分を認識しておく。積分回路３１０では、この見えないはずの部分を除いて、各時刻ｔの時のデータから算出された時刻ｔ０の時の速度を積分する。この操作によりノイズが軽減される。結果は速度メモリ３１１に記憶される。

【００７５】この速度メモリ３１１内の情報からＣＰＵ３１２により式（数６）に示した補正関数ｆ（ｖ）により、対象物１の立体形状ｚが算出される。

【００７６】以上、画像の移動として、空間フィルター２０５の平面方向の移動による画像上の各点の角速度を算出したが、本発明の目的である立体形状の算出では、検出器２０４以外の検出光学系２００自体を平面的あるいは光軸方向（対象物１に近ずけたり、遠ざけたり）に移動したり、倍率可変機構２０８により倍率を変化させても、画像は移動し、この移動をもとに式（数７）より速度を算出しても良い。

【００７７】以上、本発明は、対象物の立体形状を検出するにあたり、対象物の表面テクスチャに応じて、検出光学系の分解能、検出視野、検出時のサンプリング時間、を変化させてこれらのデータを検出し処理することに特徴がある。言い換えれば、検出画像の空間的分解能、時間的分解能を対象物に応じて、ほぼ自動的に変化させながら、画像情報を検出するところに特徴がある。即ち、空間変化率（ｄｉ／ｄｘ）および時間変化率（ｄｉ／ｄｔ）の算出に当たっては空間変化率が十分大きくなるように空間的に十分な移動量ｄδが確保できるまでの間、次のサンプリングまでの時間を（空間変化率算出の為のサンプリング時間を）大きく取り、またエッジ部のような急峻な部分では空間変化率（ｄｉ／ｄｘ）が無限大にならないように、換言すれば算出可能な程度にサンプリング時間を小さく取るようにサンプリング時間をコントロールする構成になっている。

【００７８】以上、本発明の要素技術は、高分解能かつ高ダイナミックレンジの検出器にある。以下、高ダイナミックレンジの検出器の実現方法について説明する。

【００７９】とくに、これを実現するためには、検出器２０４の信号の直後に、具体的には、検出器の光電変換直後、すなわち、検出器のチップ内に、上記の空間微分回路３０６と時間微分回路３０５を設けるのが望ましい。この場合、図１に示したようなメモリを用いた時間微分回路であってもよいが、アナログデータのまま時間微分する回路が望ましい。このような回路の実現により、実質的に、画像上のエッヂのような微分値がきわめて大きくなるような場合であっても、微分の際のｄｔを小さくすることで、微分を可能とすることができる。また、空間微分（ｄｉ／ｄｘ）の値を０にしないためには、大きなダイナミックレンジの検出器が必要になるが、これは、空間微分値を出力するような構成で実現できる。

【００８０】また図２４には、このような空間・時間微分をチップ内で実現する実施例を示す。この実施例は、２対の光電変換手段８１０、８２０、配線８３０、配線８４０より構成される。それぞれの光電変換手段８１０、８２０は陽電極８１１、８２１、陰電極８１２、８２２より構成される。一方の陽電極が他方の陰電極と結合されている。この構成によって、光電変換手段８１０で変換された電荷と光電変換手段８２０で変換された電荷の差が端子８５１、８５２に生じる。以上微分手段８５３は、この光電変換手段８１０、８２０を含むものである。

【００８１】このような光電変換手段８１０、８２０を、図２５に示すように、平面上に配置し、あるいは、図２６（ａ），（ｂ）に示すように配置し、また、１次元センサとして図２７（ａ），（ｂ）に示すように、パッケージ８５４内に配置することによって、光電変換手段８１０、８２０間で検出される光の微分値を、端子８５１、８５２間に検出することができる。このような構成により、画像の空間的な微分値を検出器上で得ることができ

る。このような構成の効果は、検出器上で微分値が得られるだけでなく、この直接微分値を得られる結果として、検出器間の差分（微分）が高精度で得られる効果がある。また、微分演算を高速で処理できることになる。

【００８２】また図２８(a)，(b)，(c)に、空間微分と時間微分を検出器上で実施する構成を示す。図２５に示した手段によって空間微分を実現し、これと並列に載置された光電変換手段８６０および微分手段８７０によって、時間微分が実施される。具体的には、微分手段８７０は、例えば、図２９に示すように微小なコイル８７１の両端に発生する電圧を計測することによって実現される。あるいは、図３０に示すように、光電変換手段８８０、８９０、電荷蓄積手段９１０、９２０、スイッチ９３０によって構成される。光電変換手段８６０によって、検出された電荷を陽極９１１、９２１、陰極９１２、９２３が互いに反対の極に接続されるようにし、この端子、９３１、９３２間に微分結果が出力される。

【００８３】また、以上の、時間微分（ｄｉ／ｄｔ）と空間微分（ｄｉ／ｄｘ）を検出器上で実施するユニットセル８５５を、図３１に示すように検出器の表面に配列し、図１に示す速度検出回路３０７をその背面に配置し、この除算結果即ち高さ情報を転送手段８５８によりシリアルに８５６の方向あるいは、パラレルに８５７の方向に出力する。この速度検出回路３０７の一例としては、時間微分結果を空間微分結果で除算する構成がよく、ユニットセル８５５の出力をユニットセル毎に除算するものである。この構成により、全ての処理がチップ内で構成できる。これにより、処理手段を小型に構成できるばかりでなく、ノイズの少ない、結果的にダイナミックレンジの大きい処理手段を構成できる。このような構成は、人の目に近い構成になっている。また、この構成は、図３１に示すように検出器の垂直方向に３層の構造に構成してもよいが、３層構造が製作が難しければ、平面内に構成してもよい。このように３層構造に構成することによって、検出器表面に対して光電変換手段の面積の比率をを大きく取れるため、検出の効果は、平面内に構成するより効率がよい。

【００８４】光源に可干渉光を用いると、焦点がずれたときに干渉による鋭い光強度変化が生じてしまい、コントラスト変化と焦点位置の変化が対応しないことがあることが実験的に確認されている。そこで、以上の実施例では、照明光として干渉しない光、時間的にも空間的にもインコヒーレントな光を用いるのが望ましい。具体的には、光源サイズの大きな白色光が望ましい。

【００８５】以上の実施例では、コントラストを算出する時、および画像の移動速度を算出するときに微分処理を用いている。微分処理は、ノイズに弱く、大きなダイナミックレンジが必要になる。

【００８６】以下、ダイナミックレンジを大きくするための検出器の実施例について図２０を用いて説明する。本実施例は光検出蓄積手段７１０、飽和検出手段７２０、電荷供給手段７３０、電荷蓄積手段７４０、電荷供給切断手段７５０、電荷転送手段７６０、７７０、光量算出手段７８０から構成される。光は、光検出蓄積手段７１０により検出、蓄積される。ここで、光検出蓄積手段７１０が飽和した際、飽和検出手段７２０により飽和したことが検出され、電荷供給切断手段７５０により、電荷供給手段７３０からの電荷蓄積手段７４０への電荷蓄積が切断される。この後、光検出蓄積手段７１０および電荷蓄積手段７４０からそれぞれの電荷転送手段７６０、７７０に電荷が移される。電荷転送手段７６０、７７０により光量算出手段７８０に転送された信号により光量が算出される。

【００８７】ここで、図２０のように光検出部が複数ある場合も同一の処理がなされる。ここで、飽和検出手段７２０は図２１に示すように、光検出蓄積手段から溢れた電荷を検出する電極７２１を光電変換手段７１０の周囲に形成した構成であっても、図２２に示すように光検出蓄積手段７１０から電荷転送手段７７０への電荷移送が飽和によりなくなり電流がなくなったことを検出してもよい。この場合の飽和検出手段７２０では、光検出蓄積手段７１０の陽極７１１から電荷転送手段７７０の陽極７７１との間に、たとえば抵抗との素子を配置し、この両端に発生する電圧を計測すればよい。

【００８８】ここで、本発明では、平面方向の検出光強度の微分、及び時間方向の検出光強度の微分をアナログの回路の状態で実施することで、より微細な変化も捕えることができる構成を実現できることを示した。本実施例は、トランジスタ、コンデンサなどの部品で構成してもよいが、固体素子として作り込んでしまうときらにこの効果が大きくなる。さらに、上記微分回路の結果を図２０に示した、光検出蓄積手段７１０の出力とすることで、微分のダイナミックレンジがさらに向上する。

【００８９】また、ここで示した、ダイナミックレンジ向上手段、及び、微分手段は、上記説明した立体形状計測手段だけでなく一般用途の光検出手段として持っても上記のダイナミックレンジの向上などの新規の効果を生むものである。

【００９０】また、以上の、立体形状検出方法は、図２３に示したように、検出ヘッド９９９とコントローラー９９８とを切り離した形状にして使用することもできる。図１０に示したように、本発明の効果は特に遠方の物体の形状認識に好都合である。従って、図２３のように構成することによって、例えば、自動車に搭載し、道路の形状、道路の状態を検出し、操縦装置と結合することで、自動の操縦装置を構成することができる。このような構成を実現することによって、例えば、居眠り運転などを防止することができる。また、人の操縦を優先することで、機械のご動作等の危険を回避することもできる。また、本発明は、ガードレール等立体的な構造物が

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DENTAL IMAGING

形成されている場合には、本発明の構成上機能を発揮しやすい。また、検出ヘッド９９９の内部の光学系の瞳の位置には可動の空間フィルターを載置すると検出ヘッド９９９を固定した状態で立体形状を計測できるが、検出ヘッそ９９９自体が動く場合は、この可動の空間フィルターはなくてもよい。もちろん有ってもよい。但し物体が高速で動くことになる自動車搭載用の検出ヘッドの場合可動フィルターを稼働させることによって返って計測時間がかかり目的の計測精度を実現できないこともある。動いているものは見つけやすい。微分値が重要なキーを握っていることの一つの証明になっている。

【００９１】さらに、医療の分野、例えば、歯の治療で、削った後の凹みの形状を計測する装置を構成することができる。この場合、検出ヘッド９９９を小型に構成するとよい。また、内視鏡と結合して使用することで、口の内部等奥まったところの観察計測を好適に実施することができる。

【００９２】さらに、本発明は、産業用として、幅広く使用できる。例えば、部品の組立作業で、部品の位置、形状を計測し自動機械につかませることを可能にし、部品組立を実現する。

【００９３】また、本発明は、検出光学系の分解能よりも画素サイズを小さくすることで、立体形状を計測可能にしている。従って、特に、広いシーンを計測する場合、第１に、検出光学系の絞りを絞って、あるいは、検出した信号を平面方向にスムージングして、低い分解能で計測し、第２に目的の計測したい部分を高い分解能で計測することが良い場合もある。特に、高速の計測を要求される場合、あるいは、対象物が、検出器の分解能と同程度の大きさのテクスチャパターンを持つ場合などである。

【００９４】

【発明の効果】本発明によれば、表面にテクスチャのない対象物、鏡面に近い面を有する対象物、滑らかな拡散面を有する奥行きの大きい対象物であっても、表面に面内方向および面に垂直な方向に高精度でテクスチャパターンを投影できるので、微細な対象物から大きな対象物まで高精度で形状検出を可能にできる。

【図面の簡単な説明】

【図１】本発明の一実施例を示すブロック図である。

【図２】照明系の他の実施例を示すブロック図である。

【図３】空間フィルターの形状を示す平面図である。

【図４】検出対象物の形状を示す側面図である。

【図５】検出信号の一つの走査線の強度分布を示す図である。

【図６】図５の信号を検出位置ｘで微分した図である。

【図７】図５の信号を検出時刻ｔで微分した図である。

【図８】速度検出結果を示す図である。

【図９】本発明の基本原理を説明するブロック図である。

【図１０】開口数に対する焦点深度と分解能を示す図である。

【図１１】本発明の一実施例を示すブロック図である。

【図１２】対象物の断面を示す図である。

【図１３】検出信号を示す図である。

【図１４】検出信号の微分結果を示す図である。

【図１５】各座標位置でのコントラスト変化を示す図である。

【図１６】本発明の他の一実施例を示す図である。

【図１７】図１６の実施例による検出画像の例を示す図である。

【図１８】本発明の他の一実施例を示す図である。

【図１９】本発明の他の一実施例を示す図である。

【図２０】本発明の検出器のブロック構成図である。

【図２１】本発明の飽和検出手段の平面的ブロック構成図である。

【図２２】本発明の飽和検出手段の側面的ブロック構成図である。

【図２３】本発明の他の一実施例の外観図である。

【図２４】空間的微分の基本チップの側面的ブロック構成図である。

【図２５】空間的微分の基本チップを配列した実施例の平面的ブロック構成図である。

【図２６】空間的微分の基本チップを配列した実施例の平面的ブロック構成図である。

【図２７】空間的微分の基本チップを配列した実施例の平面的ブロック構成図である。

【図２８】空間および時間微分の基本チップを配列した実施例の平面的ブロック構成図である。

【図２９】時間微分の基本チップの的ブロック構成図である。

【図３０】時間微分の基本チップの側面的ブロック構成図である。

【図３１】速度検出をチップ内で実施する実施例の側面的構成ブロック図である。

【符号の説明】

1…対象物、　100…照明系、　101…光源、　102…スリット

103…ハーフミラー、　104…照明レンズ、　200…検出光学系

201…対物レンズ、　202…リレーレンズ、　203…結像レンズ、　204…検出器

205…空間フィルター、　206…空間フィルター制御系、　300…信号処理系

301…平滑回路、　302、303、304…メモリ、　305…時間微分回路

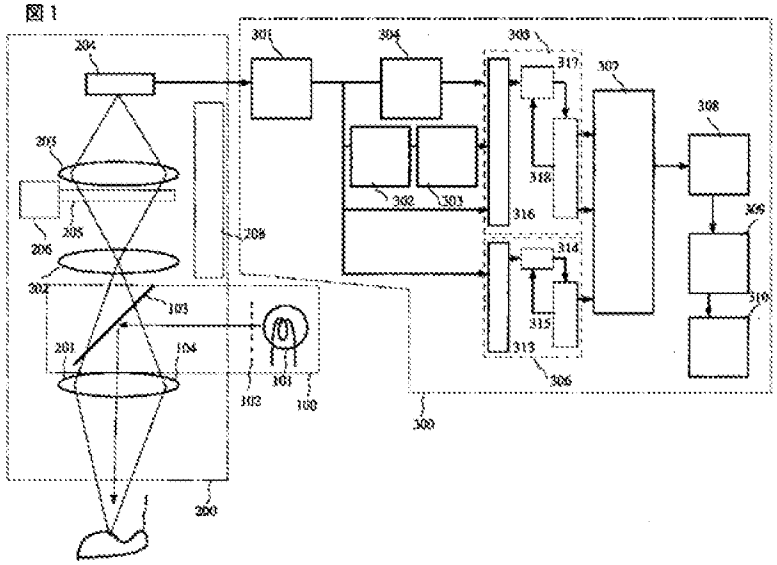
306…空間微分回路、　307…速度検出回路、　308…初速度検出回路

309…閾線処理回路、　310…積分回路、　311…速度メモリ

400…照明光学系、　500…検出光学系、　600…信号処理系、403…テクスチャパターン、　502…検出器、　601…微分回路、602、603、604、606…フレームメモリ

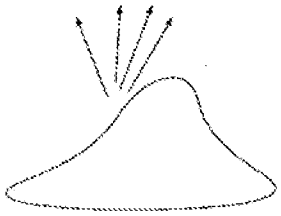
【図１】

図１



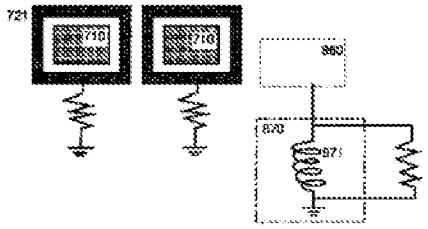
【図４】

図４



【図２１】

図２１

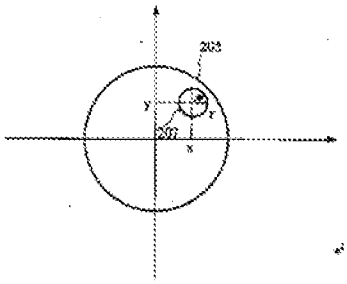


【図２９】

図２９

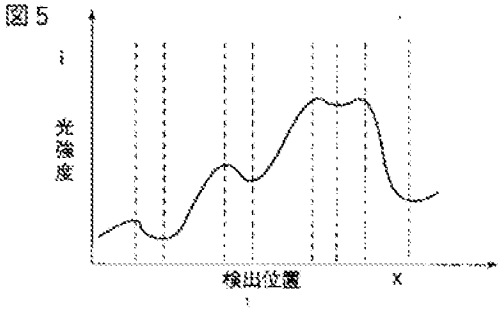
【図３】

図３



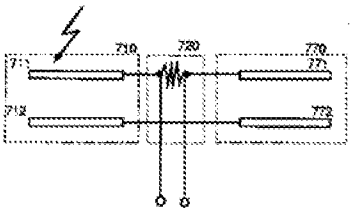
【図５】

図５



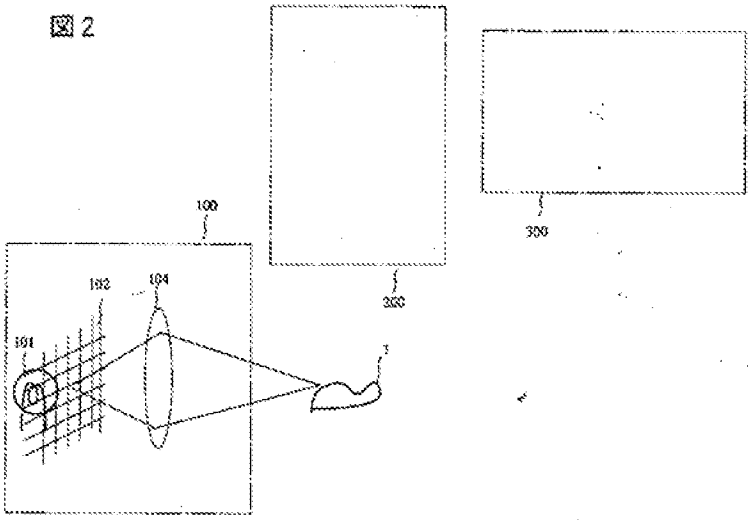
【図２２】

図２２



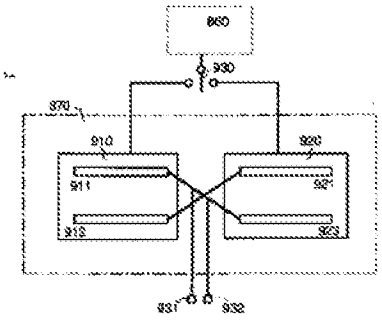
【図２】

図２



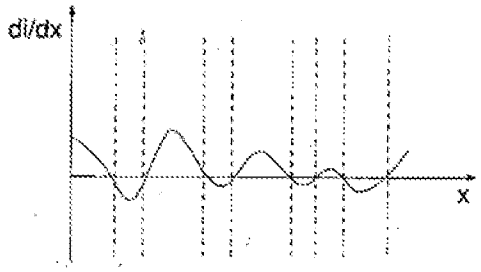
【図３０】

図３０



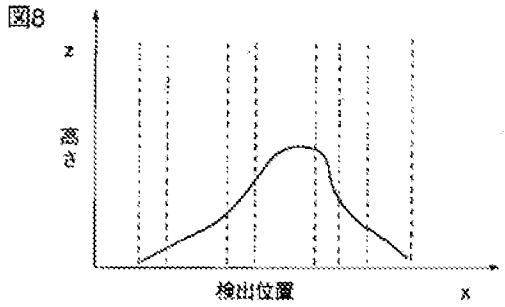
【図６】

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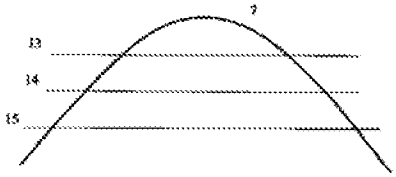
【図８】

図８



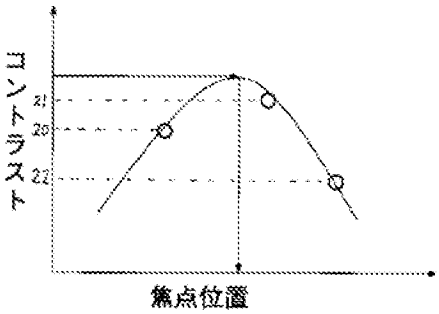
【図１２】

図１２



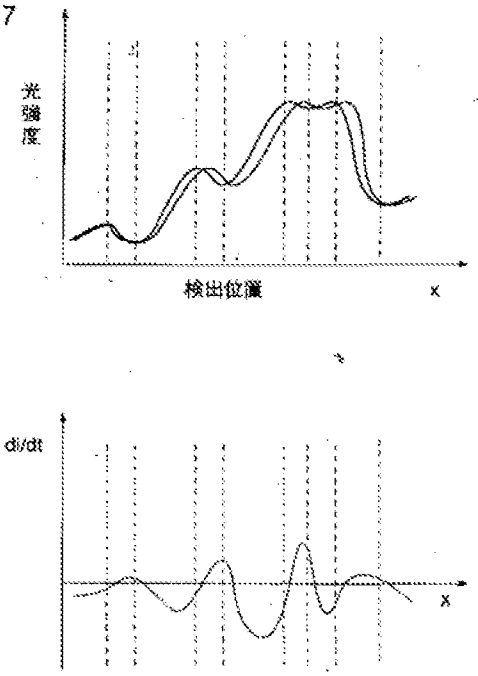
【図１５】

図１５



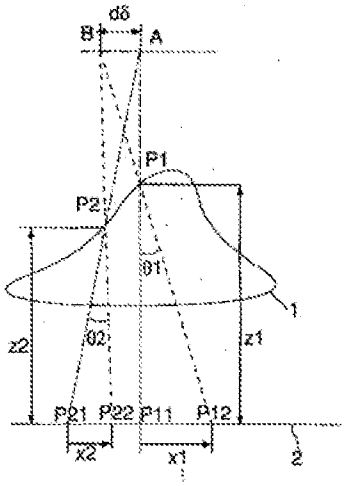
【図７】

図7



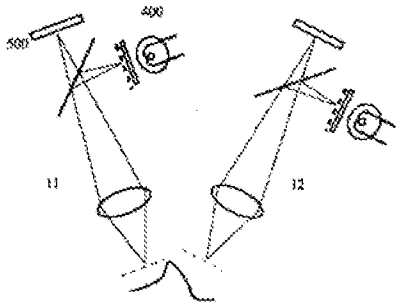
【図９】

図9



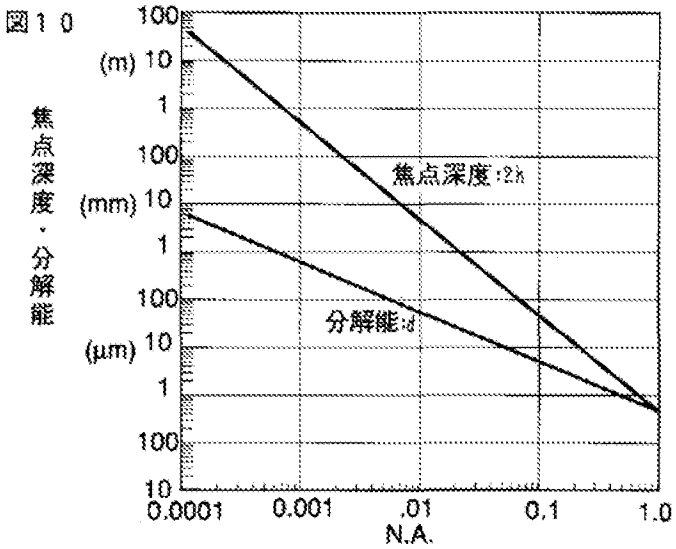
【図１８】

図１８



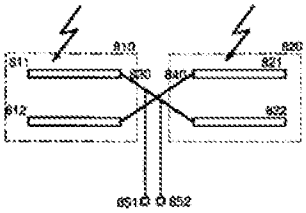
【図１０】

図１０



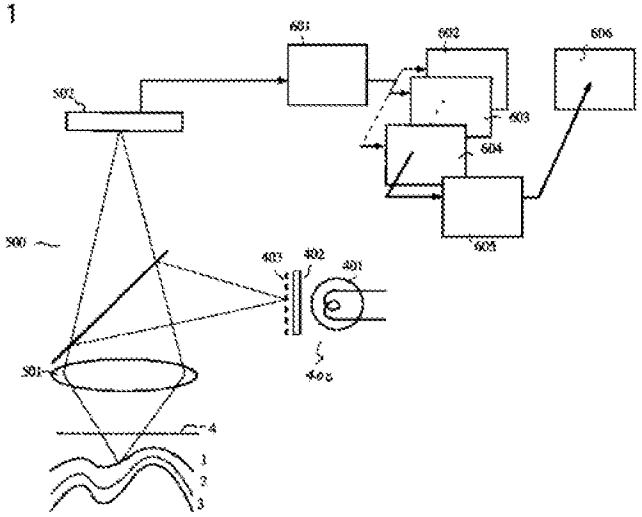
【図２４】

図２４



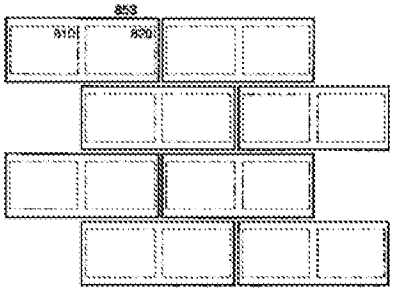
【図１１】

図１１



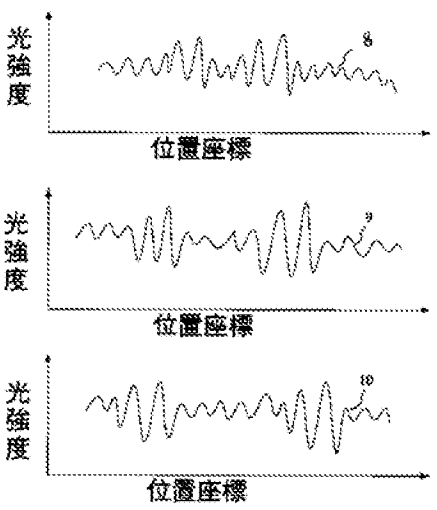
【図２５】

図２５



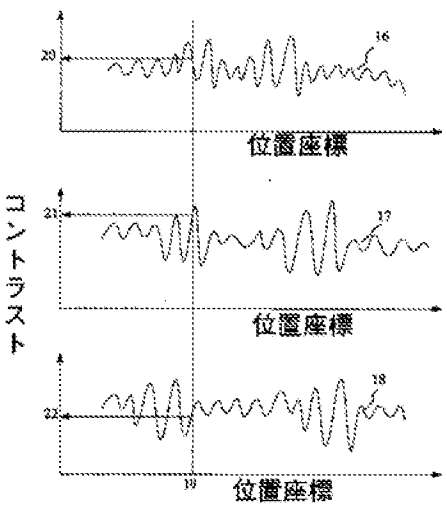
【図１３】

図１３



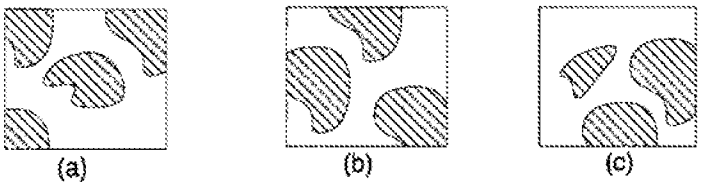
【図１４】

図１４



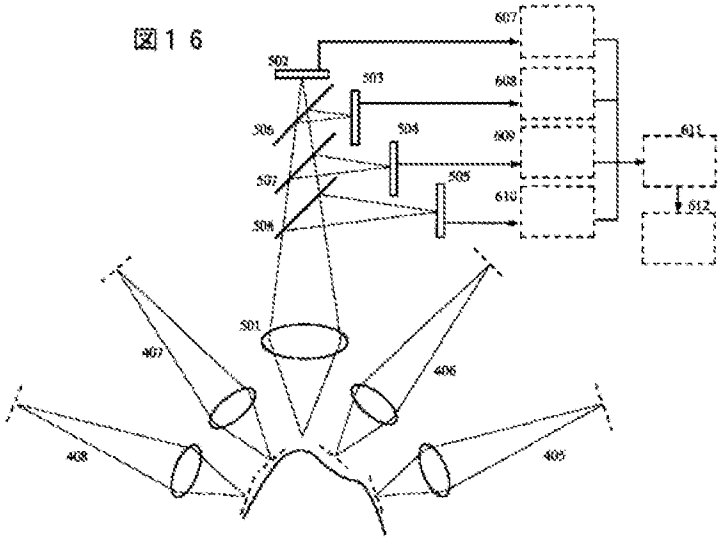
【図１７】

図１７



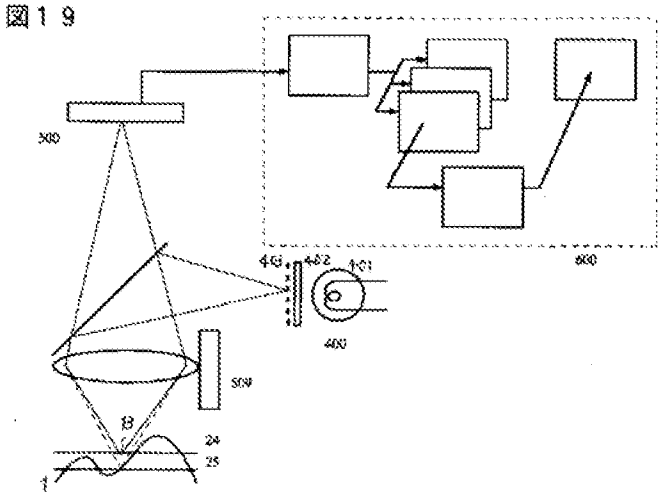
【図１６】

図１６



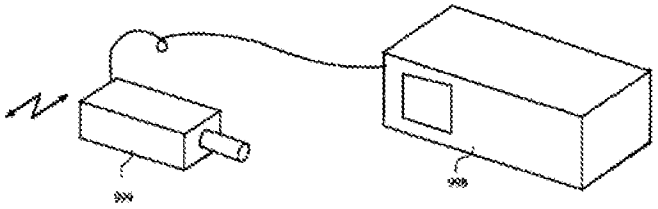
【図１９】

図１９



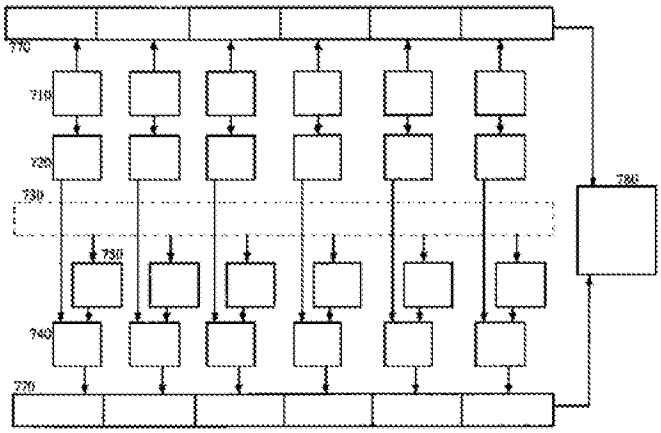
【図２３】

図２３



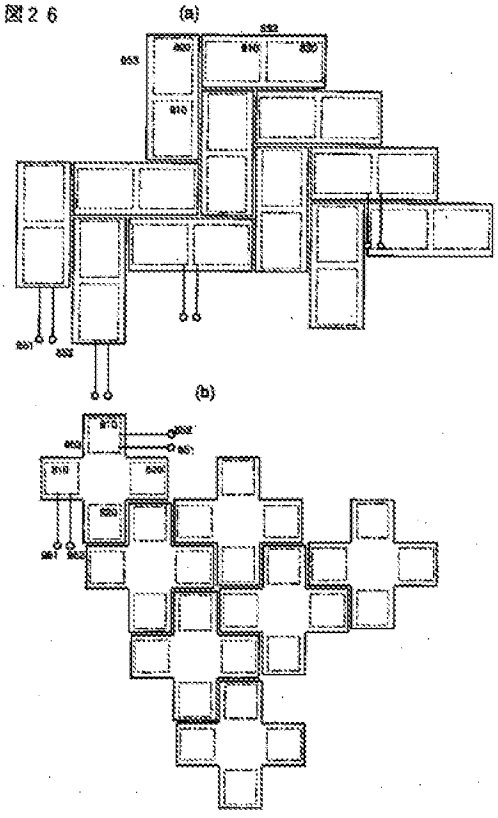
【図２０】

図２０



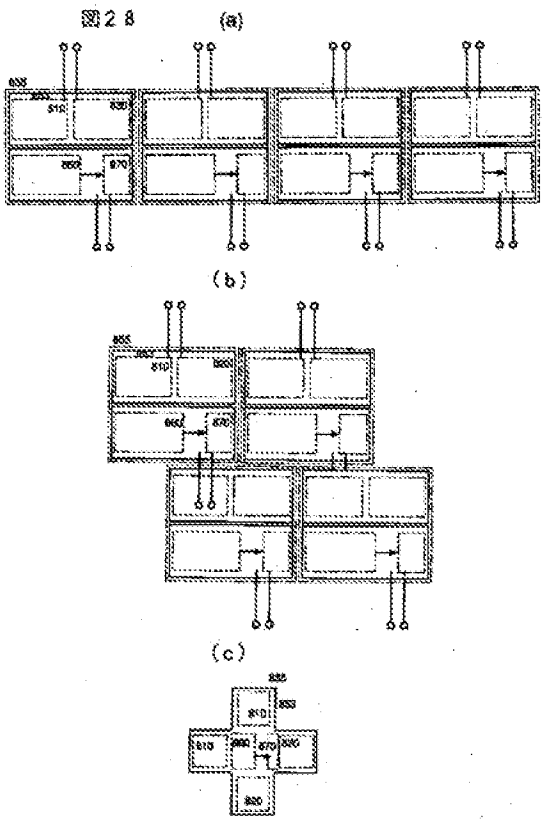
【図２６】

図２６



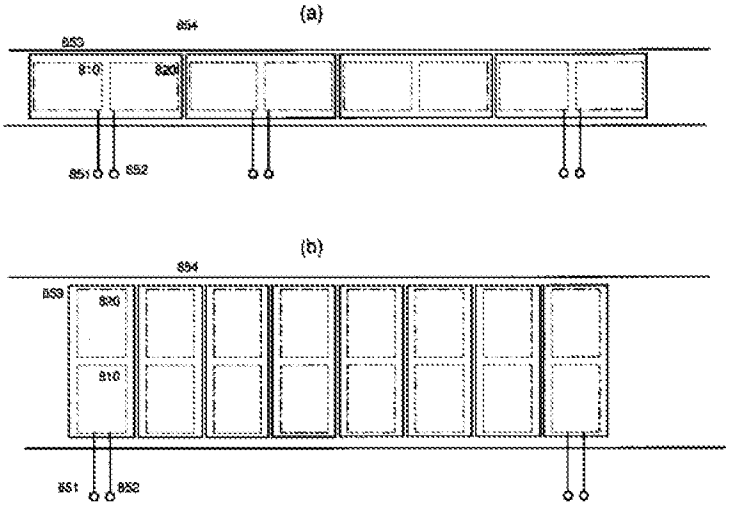
【図２８】

図２８



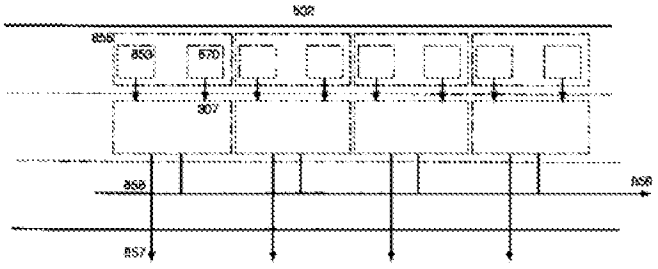
【図２７】

図２７



【図３１】

図３１



フロントページの続き

(58)調査した分野(Int.Cl.⁷，ＤＢ名)
G01B 11/00 - 11/30

Electronic Acknowledgement Receipt

EFS ID:	44902070
Application Number:	17533403
International Application Number:	
Confirmation Number:	9694
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Customer Number:	21839
Filer:	William C. Rowland/David Avila
Filer Authorized By:	William C. Rowland
Attorney Docket Number:	0079124-000370-T1
Receipt Date:	02-FEB-2022
Filing Date:	23-NOV-2021
Time Stamp:	16:06:13
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS_PTO_SB08.pdf	1036802 c8e131a6b8d9e5291bb1f58a22e43bfe58605dae	no	6

Warnings:

Information:					
2	Foreign Reference	JP3321866B2_Exhibit_1012_1013.pdf	19214237 bed2062cdf10d6b91225fa2d40ba0e8c4e4a46bb	no	39
Warnings:					
Information:					
3	Non Patent Literature	Exhibit_1002_Declaration_of_Lambertus_Hesselink_Part_1.pdf	25116433 8dd20618f51ab61851648f91a34fab1212378876b	no	95
Warnings:					
Information:					
4	Non Patent Literature	Exhibit_1002_Declaration_of_Lambertus_Hesselink_Part_2.pdf	25051421 1138f056fc20f3346baf7d7a52696d39f6f75147	no	84
Warnings:					
Information:					
5	Non Patent Literature	Exhibit_1002_Declaration_of_Lambertus_Hesselink_Part_3.pdf	3842355 4c87f84b2af9ea33a8f78f7b3880a13ddbf757b0	no	14
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6	Non Patent Literature	Exhibit_1052_November_12_2020_Order.pdf	462543 8507380953e2a307ece775f997e108b129aa510d	no	2
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Information:					
7	Non Patent Literature	Exhibit_1053_Stipulation_of_Invalidity_Contentions.pdf	731736 1c79dfa4188730c2ab20e00d2a32bdefe7bb75fa	no	3
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8	Non Patent Literature	Exhibit_1056_Sergienko_Deposition_Transcript_Part_1.pdf	20921778 786a6417745cc1c8a71dfb38be5180b779bdd2ea	no	89
Warnings:					
Information:					

9	Non Patent Literature	Exhibit_1056_Sergienko_Deposition_Transcript_Part_2.pdf	20908162 be1cc543a38923b103db97396236311b07d289cf	no	81
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11	Non Patent Literature	Exhibit_1057_Hesselink_Reply_Declaration.pdf	11091419 6a5d0ba339ab3ead39f59372ccfbf15ad5c9312b	no	38
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12	Non Patent Literature	Exhibit_1061_Sergienko_Declaration.pdf	21259635 f0b89552b20a46f2555bd4d18dfcb9adec06b3c0	no	79
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13	Non Patent Literature	Exhibit_1062_POPR_in_IPR2020.pdf	21903357 68091dcc5ae531b654ef091bc7fe5d5ef405a2a8	no	78
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14	Non Patent Literature	Exhibit_1063_Petition_for_IPR_in_IPR2019_00157.pdf	21635096 8d2c15c2b5484d808c251977bed8403874c4273c	no	81
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15	Non Patent Literature	Exhibit_1064_Fraser.pdf	7081705 d739e9bcb5cff9e3041732d95341ecb5dace755c	no	10
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Information:					

16	Non Patent Literature	Exhibit_1065_Smith_Part_1.pdf	26110896 c2274e324d2802d356cd56a8a52bc958d885996d	no	67
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17	Non Patent Literature	Exhibit_1065_Smith_Part_2.pdf	25379567 ad73baca6a956ff0f45b6d7eac5e2f10a6c4a671	no	38
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18	Non Patent Literature	Exhibit_2019_Sergienko_Declaration_IPR2020_01087.pdf	24189765 eedc56faa33c44bd399ae0abea59aefbd6bb3e68	no	92
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19	Non Patent Literature	Exhibit_2022_Memorandum_Order_12_28_20.pdf	945699 21184874c2703ba0d830cc0b86a10382dd2ac35b	no	3
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20	Non Patent Literature	Exhibit_2023_Hesselink_Transcript04022021_Part_1.pdf	24708558 488a19f7e1fb07e4d3fc4e5894cf45a82eac323a	no	37
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21	Non Patent Literature	Exhibit_2023_Hesselink_Transcript04022021_Part_2.pdf	25002745 6387c8724b35d370d9325cf8e7512dc48b9d605d	no	45
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22	Non Patent Literature	Exhibit_2023_Hesselink_Transcript04022021_Part_3.pdf	673342 cc2768a9b27ac050bf74fbdf1e85b63f691e6766	no	2
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Information:					

23	Non Patent Literature	Exhibit_2027_Willson_Dynamic_Lens_Compensation.pdf	7142171 0de8330b3a748fb040ba8ba691618ced23a07d07	no	52
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24	Non Patent Literature	Exhibit_2028_Darrell_Pyramid_Based_Depth_from_Focus.pdf	1548359 e8c1cb7e667ad6a9ba8c023850eac8977c476c86	no	6
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25	Non Patent Literature	Exhibit_2029_Hall_Ellis_Declaration_IPR2020_01087_Part_1.pdf	23856555 1dde582d90d6276dd13cd58b28d8658467b1832f	no	60
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26	Non Patent Literature	Exhibit_2029_Hall_Ellis_Declaration_IPR2020_01087_Part_2.pdf	24062983 9469fdf2aecc37821c1b0a6e4a11482c08461035	no	91
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27	Non Patent Literature	Exhibit_2029_Hall_Ellis_Declaration_IPR2020_01087_Part_3.pdf	10792687 59919b57e1ec23903cfd81997c91b5d63ed6538a	no	65
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28	Non Patent Literature	Exhibit_2030_Hesselink_Transcript_9_10_2021.pdf	15172124 e7a4a1c42be4a47b82d7578d1c0cb648318b11f3	no	28
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29	Non Patent Literature	Final_Written_Decision_01192022.pdf	21389743 488c4c463c49cf38bbccd66bcf74b114c760cee6	no	59
Warnings:					
Information:					
		Total Files Size (in bytes):	448485696		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	17533403
Filing Date	23-Nov-2021
First Named Inventor	Rune FISKER
Attorney Docket Number	0079124-000370-T1
Title of Invention	FOCUS SCANNING APPARATUS

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
3Shape A/S	100%

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

11076146

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○	I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicant claims the following fee status:

○ Small Entity

○ Micro Entity

◉ Regular Undiscounted

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 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Registration Number 30888

○ A sole inventor

○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application

○ A joint inventor; all of whom are signing this request

Signature	/WCRowland/
Name	William C. Rowland

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	17533403
Filing Date:	23-Nov-2021
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Filer:	William C. Rowland
Attorney Docket Number:	0079124-000370-T1

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	1814	1	170	170
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**170**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 17533403

Filing Date: 23-Nov-2021

Applicant/Patent under Reexamination: FISKER

Electronic Terminal Disclaimer filed on February 2, 2022

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt

EFS ID:	44896036
Application Number:	17533403
International Application Number:	
Confirmation Number:	9694
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Customer Number:	21839
Filer:	William C. Rowland
Filer Authorized By:	
Attorney Docket Number:	0079124-000370-T1
Receipt Date:	02-FEB-2022
Filing Date:	23-NOV-2021
Time Stamp:	09:37:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$170
RAM confirmation Number	E202222037450137
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	41270 88e1932a9d878d972155247727986fc313885d51	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37853 8809b09432a25508ec1b9ac655968004bc36b122	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	79123		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/533,403	11/23/2021	Rune FISKER	0079124-000370-T1	9694

21839 7590 01/13/2022

BUCHANAN, INGERSOLL & ROONEY PC
1737 KING STREET
SUITE 500
ALEXANDRIA, VA 22314-2727

EXAMINER
CENTRAL, DOCKET

ART UNIT	PAPER NUMBER
OPAP	

NOTIFICATION DATE	DELIVERY MODE
01/13/2022	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ADIPDOC1@BIPC.com

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 17/533,403	**Applicant(s)** FISKER et al.	
	Examiner CHERYL P GIBSON BAYLOR	**Art Unit** OPET	**AIA (FITF) Status** No

1. THE REQUEST FILED 23 November 2021 IS **GRANTED** .

   The above-identified application has met the requirements for prioritized examination
   - A. ☑ for an original nonprovisional application (Track I).
   - B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:
   - A. filing a **petition for extension of time** to extend the time period for filing a reply;
   - B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;
   - C. filing a **request for continued examination** ;
   - D. filing a notice of appeal;
   - E. filing a request for suspension of action;
   - F. mailing of a notice of allowance;
   - G. mailing of a final Office action;
   - H. completion of examination as defined in 37 CFR 41.102; or
   - I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to CHERYL GIBSON BAYLOR at (571)272-3213. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/CHERYL GIBSON BAYLOR/ Paralegal Specialist, OPET	

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER
Art Unit	
Examiner Name	
Attorney Docket Number	0079124-000370-T1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	RE48,221	E	2020-09-22	ÖJELUND, ET AL.	
	2	10695151	B1	2020-06-30	ESBECH, ET AL.	
	3	11076146	B1	2021-07-27	FISKER, ET AL.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17533403
Filing Date	2021-11-23
First Named Inventor	Rune FISKER
Art Unit	
Examiner Name	
Attorney Docket Number	0079124-000370-T1

If you wish to add additional Foreign Patent Document citation information please click the Add button [Add]

NON-PATENT LITERATURE DOCUMENTS [Remove]

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	COMPLAINT, 3Shape A/S v. Carestream Dental, LLC, Civil Action No. 6:21-cv-1110, WDTX, October 26, 2021, 59 pages.	

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17533403
	Filing Date	2021-11-23
	First Named Inventor	Rune FISKER
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0079124-000370-T1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

✓ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Travis D. Boone/	Date (YYYY-MM-DD)	2022-01-05
Name/Print	Travis D. Boone	Registration Number	52,635

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Exhibit 1004 page 1480 of 1621
DENTAL IMAGING

Electronic Acknowledgement Receipt

EFS ID:	44670860
Application Number:	17533403
International Application Number:	
Confirmation Number:	9694
Title of Invention:	FOCUS SCANNING APPARATUS
First Named Inventor/Applicant Name:	Rune FISKER
Customer Number:	21839
Filer:	Travis Dean Boone/Snjezana Gvozderac
Filer Authorized By:	Travis Dean Boone
Attorney Docket Number:	0079124-000370-T1
Receipt Date:	05-JAN-2022
Filing Date:	23-NOV-2021
Time Stamp:	11:15:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	PTO_SB_08.pdf	1035058 8e1cabc78bc7d055555efbd38a806c8d75ac7689	no	4

Warnings:

Information:					
2	Other Reference-Patent/App/Search documents	NPL1_Complain_20211026.pdf	13232935 28a7abcec5cf195f07a72c961d11f1c993c81aa4	no	59
Warnings:					
Information:					
			Total Files Size (in bytes):	14267993	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/533,403	11/23/2021	2878	2820	0079124-000370-T1	30	3

CONFIRMATION NO. 9694

FILING RECEIPT

21839
BUCHANAN, INGERSOLL & ROONEY PC
1737 KING STREET
SUITE 500
ALEXANDRIA, VA 22314-2727

OC000000130280983

Date Mailed: 12/08/2021

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Rune FISKER, Virum, DENMARK;
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Rasmus KJAER, Kobenhavn K, DENMARK;
Mike VAN DER POEL, Rodovre, DENMARK;
Arish A. QAZI, Toronto, CANADA;
Karl-Josef HOLLENBECK, Copenhagen O, DENMARK;

Applicant(s)

3SHAPE A/S, Copenhagen K, DENMARK

Assignment For Published Patent Application

3SHAPE A/S, Copenhagen K, DENMARK

Power of Attorney: The patent practitioners associated with Customer Number 21839

Domestic Priority data as claimed by applicant

This application is a CON of 17/340,806 06/07/2021
which is a CON of 17/206,581 03/19/2021 PAT 11076146
which is a CON of 16/774,843 01/28/2020 PAT 11051002
which is a CON of 16/433,369 06/06/2019 PAT 10595010
which is a CON of 16/217,943 12/12/2018 PAT 10326982
which is a CON of 15/974,105 05/08/2018 PAT 10349041
which is a CON of 14/502,230 09/30/2014 PAT 10097815
which is a CON of 13/376,427 12/06/2011 PAT 8878905
which is a 371 of PCT/DK2010/050148 06/17/2010

which claims benefit of 61/231,118 08/04/2009
and claims benefit of 61/187,744 06/17/2009

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 12/06/2021

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/533,403**

Projected Publication Date: 03/17/2022

Non-Publication Request: No

Early Publication Request: No
Title

FOCUS SCANNING APPARATUS

Preliminary Class

250

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application

serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

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SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 17/533,403

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	700
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	30 minus 20 =	* 10			OR	x 100 =	1000
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 480 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2820

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

User :C46910

Refund Accounting Date:12/07/2021

Effective Date	Sale Item Reference Number	Refund Total
11/23/2021	17533403	$160.00

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method	Account Number
I2021B7908503513	1051	LATE FILING FEE FOR OATH OR DECLARATION	$160.00	DA	024800



United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

User :C46910

Sale Adjustment Accounting Date:12/07/2021

Effective Date	Sale Accounting Date	Sale Item Reference Number
11/23/2021	12/07/2021	17533403

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method
I2021B7908503513	1051	LATE FILING FEE FOR OATH OR DECLARATION	$160.00	DA



United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

User :C46910

Sale Accounting Date:12/06/2021

Sale Item Reference Number	Effective Date
17533403	11/23/2021

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method
I2021B6F10560619	1051	LATE FILING FEE FOR OATH OR DECLARATION	$160.00	Deposit Account

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 17/533,403	Filing Date 11/23/2021	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $480 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT	11/23/2021	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 30	Minus	** 30	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LDRC
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/EVA V GILLIS/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Rune FISKER	Nonprovisional Application Number (if known):	
Title of Invention:	FOCUS SCANNING APPARATUS		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /WCRowland/	Date 2021-11-23
Name (Print/Typed) William C. Rowland	Practitioner Registration Number 30,888

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☐ *Total of _____ forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
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	Filing Date	
	First Named Inventor	Rune FISKER
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	Attorney Docket Number	0079124-000370-T1

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