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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/474,702	02/13/2018	9892564	N3039.10001US01	9851

97149 7590 01/24/2018
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

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 Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Steven Cvetko, Draper, UT;
Novarad Corporation, American Fork, UT;
Wendell Arlen Gibby, Mapleton, UT;

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 USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.



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NOTICE OF ALLOWANCE AND FEE(S) DUE

97149 7590 12/15/2017
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

EXAMINER

GRAY, RYAN M

ART UNIT

PAPER NUMBER

2611

DATE MAILED: 12/15/2017

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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15/474,702

03/30/2017

Steven Cvetko

N3039.10001US01

9851

TITLE OF INVENTION: AUGMENTING REAL-TIME VIEWS OF A PATIENT WITH THREE-DIMENSIONAL DATA

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	03/15/2018

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 and an extra copy of the form should be submitted. 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), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (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)

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.

97149 7590 12/15/2017
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

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 facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/474,702	03/30/2017	Steven Cvetko	N3039.10001US01	9851

TITLE OF INVENTION: AUGMENTING REAL-TIME VIEWS OF A PATIENT WITH THREE-DIMENSIONAL DATA

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	03/15/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
GRAY, RYAN M	2611	345-426000

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/SB/122) attached. ☐ "Fee Address" indication (or "Fee Address" Indication form 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, 1 _____ (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. 2 _____ 3 _____
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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 has been filed for recordation as set forth in 37 CFR 3.11. 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. The following fee(s) are submitted: ☐ Issue Fee ☐ Publication Fee (No small entity discount permitted) ☐ Advance Order - # of Copies _____	4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above) ☐ A check is enclosed. ☐ Payment by credit card. Form PTO-2038 is attached. ☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).
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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. _____



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/474,702	03/30/2017	Steven Cvetko	N3039.10001US01	9851
97149	7590	12/15/2017	EXAMINER	
Maschoff Brennan 1389 Center Drive, Suite 300 Park City, UT 84098			GRAY, RYAN M	
			ART UNIT	PAPER NUMBER
			2611	
DATE MAILED: 12/15/2017				

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 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, 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.

<i>Applicant-Initiated Interview Summary</i>	Application No. 15/474,702	Applicant(s) CVETKO ET AL.	
	Examiner RYAN M. GRAY	Art Unit 2611	

All participants (applicant, applicant's representative, PTO personnel):

(1) RYAN M. GRAY. (3) ____.

(2) JOHN T. GADD. (4) ____.

Date of Interview: 28 November 2017.

Type: ☐ Telephonic ☒ Video Conference
 ☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
 If Yes, brief description: ____.

Issues Discussed ☐101 ☐112 ☐102 ☒103 ☐Others
 (For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1.

Identification of prior art discussed: ____.

Substance of Interview
 (For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

WebEx Interview to discussed amendments incorporating allowable subject matter indicated in the prior Final Rejection. The current amendments were discussed with respect to the previously objected claims and agreement was reached on allowable independent claims.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/RYAN M GRAY/ Primary Examiner, Art Unit 2611	
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Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record

A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews

Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.

All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

- 1) A brief description of the nature of any exhibit shown or any demonstration conducted,
- 2) an identification of the claims discussed,
- 3) an identification of the specific prior art discussed,
- 4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
- 5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
- 6) a general indication of any other pertinent matters discussed, and
- 7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

Notice of Allowability	Application No. 15/474,702	Applicant(s) CVETKO ET AL.	
	Examiner RYAN M. GRAY	Art Unit 2611	AIA (First Inventor to File) Status Yes

-- 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 11/28/17.
☐ 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 1-17 and 19-23. 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) | 5. ☐ Examiner's Amendment/Comment |
| 2. ☐ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date _____ | 6. ☒ Examiner's Statement of Reasons for Allowance |
| 3. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material | 7. ☒ Other <u>PTO-2323</u> . |
| 4. ☒ Interview Summary (PTO-413),
Paper No./Mail Date _____. | |

/RYAN M GRAY/
Primary Examiner, Art Unit 2611

Reasons for Allowance

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

The following is an examiner's statement of reasons for allowance:

With regard to claims 1, 11, 12, 14 and 20: The cited prior art lacks the virtual spatial difference box as claimed. As shown by Applicant's Figure 1, the virtual spatial difference box is projected onto and contains the surgical data.

Maier discloses projection of an internal volume (see Fig. 2), but does not disclose a virtual box that contains the volume. Maier, ¶ 132 discloses a slice view, but does not use a virtual spatial difference box.

Razzauque discloses a slice view and volume box but does not suggest projection onto and containment of a surgical image.

Claim 8 is allowable because the cited references lack the additional feature of inclusion of markers to aide in tracking under an opaque surgical drape.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to RYAN M. GRAY whose telephone number is (571)272-4582. The examiner can normally be reached on Monday through Friday, 9:00 am - 5:00 pm.

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, Kee Tung can be reached on (571) 272-7794. 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.

Application/Control Number: 15/474,702
Art Unit: 2611

Page 4

/RYAN M GRAY/
Primary Examiner, Art Unit 2611

<i>Applicant-Initiated Interview Summary</i>	Application No. 15/474,702	Applicant(s) CVETKO ET AL.	
	Examiner RYAN M. GRAY	Art Unit 2611	

All participants (applicant, applicant's representative, PTO personnel):

(1) RYAN M. GRAY. (3) ____.

(2) JOHN T. GADD. (4) ____.

Date of Interview: 28 November 2017.

Type: ☐ Telephonic ☒ Video Conference
 ☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
 If Yes, brief description: ____.

Issues Discussed ☐101 ☐112 ☐102 ☒103 ☐Others
 (For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1.

Identification of prior art discussed: ____.

Substance of Interview
 (For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

WebEx Interview to discussed amendments incorporating allowable subject matter indicated in the prior Final Rejection. The current amendments were discussed with respect to the previously objected claims and agreement was reached on allowable independent claims.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/RYAN M GRAY/ Primary Examiner, Art Unit 2611	
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Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record

A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews

Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.

All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

- 1) A brief description of the nature of any exhibit shown or any demonstration conducted,
- 2) an identification of the claims discussed,
- 3) an identification of the specific prior art discussed,
- 4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
- 5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
- 6) a general indication of any other pertinent matters discussed, and
- 7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

AFCP 2.0 Decision

Application No.

15/474,702

Applicant(s)

CVETKO ET AL.

Examiner

RYAN M. GRAY

Art Unit

2611

This is in response to the After Final Consideration Pilot request filed 28 November 2017.

1. **Improper Request** – The AFCP 2.0 request is improper for the following reason(s) and the after final amendment submitted with the request will be treated under pre-pilot procedure.

- ☐ An AFCP 2.0 request form PTO/SB/434 (or equivalent document) was not submitted.
- ☐ A non-broadening amendment to at least one independent claim was not submitted.
- ☐ A proper AFCP 2.0 request was submitted in response to the most recent final rejection.
- ☐ Other:

2. **Proper Request**

A. After final amendment submitted with the request will not be treated under AFCP 2.0.

The after final amendment cannot be reviewed and a search conducted within the guidelines of the pilot program.

- ☐ The after final amendment will be treated under pre-pilot procedure.

B. Updated search and/or completed additional consideration.

The examiner performed an updated search and/or completed additional consideration of the after final amendment within the time authorized for the pilot program. The result(s) of the updated search and/or completed additional consideration are:

- ☒ 1. All of the rejections in the most recent final Office action are overcome and a Notice of Allowance is issued herewith.
- ☐ 2. The after final amendment would not overcome all of the rejections in the most recent final Office action. See attached interview summary for further details.
- ☐ 3. The after final amendment was reviewed, and it raises a new issue(s). See attached interview summary for further details.
- ☐ 4. The after final amendment raises new issues, but would overcome all of the rejections in the most recent final Office action. A decision on determining allowability could not be made within the guidelines of the pilot. See attached interview summary for further details, including any newly discovered prior art.
- ☐ 5. Other:

Examiner Note: Please attach an interview summary when necessary as described above.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Steven Cvetko	Art Unit 2611
Application No.:	15/474,702	
Filed:	March 30, 2017	
Conf. No.:	9851	
For:	AUGMENTING REAL-TIME VIEWS OF A PATIENT WITH THREE-DIMENSIONAL DATA	
Examiner:	Ryan M. Gray	
Customer No.:	97149	
Attorney Docket No.:	N3039.10001US01	

AMENDMENT AND RESPONSE TO OFFICE ACTION

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Final Office Action dated November 2, 2017 (the “Office Action”), please consider the following:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 11 of this paper.

CERTIFICATION AND REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0		
Practitioner Docket No.: N3039.10001US01	Application No.: 15/474,702	Filing Date: March 30, 2017
First Named Inventor: Steven Cvetko	Title: AUGMENTING REAL-TIME VIEWS OF A PATIENT WITH THREE-DIMENSIONAL DATA	
APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0 (AFCP 2.0) OF THE ACCOMPANYING RESPONSE UNDER 37 CFR 1.116. 1. The above-identified application is (i) an original utility, plant, or design nonprovisional application filed under 35 U.S.C. 111(a) [a continuing application (<i>e.g.</i>, a continuation or divisional application) is filed under 35 U.S.C. 111(a) and is eligible under (i)], or (ii) an international application that has entered the national stage in compliance with 35 U.S.C. 371(c). 2. The above-identified application contains an outstanding final rejection. 3. Submitted herewith is a response under 37 CFR 1.116 to the outstanding final rejection. The response includes an amendment to at least one independent claim, and the amendment does not broaden the scope of the independent claim in any aspect. 4. This certification and request for consideration under AFCP 2.0 is the only AFCP 2.0 certification and request filed in response to the outstanding final rejection. 5. Applicant is willing and available to participate in any interview requested by the examiner concerning the present response. 6. This certification and request is being filed electronically using the Office's electronic filing system (EFS-Web). 7. Any fees that would be necessary consistent with current practice concerning responses after final rejection under 37 CFR 1.116, <i>e.g.</i>, extension of time fees, are being concurrently filed herewith. [There is no additional fee required to request consideration under AFCP 2.0.] 8. By filing this certification and request, applicant acknowledges the following: • Reissue applications and reexamination proceedings are not eligible to participate in AFCP 2.0. • The examiner will verify that the AFCP 2.0 submission is compliant, <i>i.e.</i>, that the requirements of the program have been met (see items 1 to 7 above). For compliant submissions: ○ The examiner will review the response under 37 CFR 1.116 to determine if additional search and/or consideration (i) is necessitated by the amendment and (ii) could be completed within the time allotted under AFCP 2.0. If additional search and/or consideration is required but cannot be completed within the allotted time, the examiner will process the submission consistent with current practice concerning responses after final rejection under 37 CFR 1.116, <i>e.g.</i>, by mailing an advisory action. ○ If the examiner determines that the amendment does not necessitate additional search and/or consideration, or if the examiner determines that additional search and/or consideration is required and could be completed within the allotted time, then the examiner will consider whether the amendment places the application in condition for allowance (after completing the additional search and/or consideration, if required). If the examiner determines that the amendment does not place the application in condition for allowance, then the examiner will contact the applicant and request an interview. ▪ The interview will be conducted by the examiner, and if the examiner does not have negotiation authority, a primary examiner and/or supervisory patent examiner will also participate. ▪ If the applicant declines the interview, or if the interview cannot be scheduled within ten (10) calendar days from the date that the examiner first contacts the applicant, then the examiner will proceed consistent with current practice concerning responses after final rejection under 37 CFR 1.116.		
Signature /John T. Gadd/	Date 2017-11-28	
Name (Print/Typed) John T. Gadd	Practitioner Registration No. 52928	
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, see below*.		
☒ * Total of <u>1</u> 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.
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.

REMARKS

The paper is in response to the Office Action. The foregoing amendment cancels claim 18; amends claims 1, 7, 8, 12, 14, and 19; and adds new claims 21-23. Claims 1-17 and 19-23 are now pending in view of the amendments. Applicants respectfully request reconsideration of the application in view of the above amendments to the claims and the following remarks. For Examiner's convenience and reference, Applicants present remarks in the order that the Office Action raises the corresponding issues.

Unless otherwise explicitly stated, the term "Applicants" is used herein generically and may refer to a single inventor, a set of inventors, an appropriate assignee, or any other entity or person with authority to prosecute this application.

Examiner's Interview

Applicants thank Examiner for the WebEx interview of November 28, 2017 (the "Interview"). The amendments and remarks herein reflect the substance of the Interview. In particular, the amendments herein were discussed with Examiner during the Interview.

Allowable Subject Matter

The Office Action rejects claims 1-7, 9-17, 19, and 20 for various reasons.

The Office Action also objects to claims 8 and 18 as being dependent on a rejected base claim, but indicates that claims 8 and 18 would be allowable if rewritten in independent form to include all of the elements of the base claim and any intervening claims.

Applicants do not necessarily agree with any of Examiner's statements regarding at least (1) whether the cited reference(s) disclose each and every element recited in the rejected claims, (2) whether the cited reference(s) teach the combination presented in the rejected claims, (3) whether the cited reference(s) disclose or inherently include the features that the Office Action asserts that the reference(s) include, and (4) whether the reference(s) or any other source provide a reason to combine the teachings of the reference(s).

Nevertheless, in the interest of expediting prosecution, Applicants herein amend the claims to place the claims in allowable form based on allowable subject matter from claims 8 and 18.

In particular, as discussed in the Interview, Applicants have rewritten allowable dependent claim 8 in independent form to incorporate elements similar or identical to some or all of the elements of the prior version of independent claim 1. Applicants therefore respectfully request that Examiner withdraw the objection to allowable dependent claim 8.

Further, as discussed in the Interview, Applicants have herein amended independent claims 1, 12, and 14 to incorporate elements similar or identical to some or all of the elements of allowable claim 18, rendering Examiner's rejections moot. Applicants therefore respectfully request that Examiner withdraw the rejections of claims 1, 12, and 14, and of claims 2-7, 9-11, 13, 15-17, 19, and 20 which depend therefrom.

Finally, as discussed in the Interview, Applicant have also herein amended dependent claims 7 and 19 to place these claims in better condition for allowance.

Applicants expressly reserve the right to present claims similar or identical to the preamendment versions of claims 1-20 in another application.

New Claims

Support for new claims 21-23 can be found at least in paragraphs [0031] and [0037] of the specification.

Inasmuch as new claims 21-23 depend from allowable independent claim 1, Applicants respectfully request that new claims 21-23 also be allowed.

Charge Authorization

The Commissioner is hereby authorized to charge payment of any of the following fees that may be applicable to this communication, or credit any overpayment, to Deposit Account No. 50-5394: (1) any filing fees required under 37 C.F.R. § 1.16; (2) any patent application and reexamination processing fees under 37 C.F.R. § 1.17; and/or (3) any post issuance fees under 37 C.F.R. § 1.20. In addition, if any additional extension of time is required, which has not otherwise been requested, please consider this a petition therefor and charge any additional fees that may be required to Deposit Account No. 50-5394.

CONCLUSION

In view of the foregoing, and consistent with the discussion during the Interview, Applicants submit that the pending claims are allowable. In the event that Examiner finds remaining impediment to a prompt allowance of this application that may be clarified through a telephone interview or overcome by an Examiner's Amendment, Examiner is requested to contact the undersigned attorney.

Dated this 28th day of November, 2017.

Respectfully submitted,

/John T. Gadd/

JOHN T. GADD
Registration No. 52,928
Attorney for Applicants
Customer No. 97149
Telephone No. (435) 252-1360

AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions and listings of claims in the application:

1. (Currently Amended) A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

determining virtual morphometric measurements, including size and shape, of the outer layer of the patient from the 3D data;

mapping a 3D space;

registering a real-time position of the outer layer of the patient in the 3D space by mapping the position of the outer layer of the patient within the 3D space;

determining real-time morphometric measurements, including size and shape, of the outer layer of the patient;

automatically registering a virtual position of the outer layer of the patient from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space using the virtual morphometric measurements and using the real-time morphometric measurements; and

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient, the projected inner layer of the patient from the 3D data being confined within a volume of a virtual spatial difference box, the real-time views being non-image actual views.

2. (Previously presented) The method of claim 1, wherein:

the registering of the real-time position and the determining of the real-time morphometric measurements are accomplished using sensors included in the AR headset; and

the sensors include one or more of infrared sensors, sound sensors, fluoroscopy sensors, accelerometers, gyroscopes, and magnetometers.
3. (Original) The method of claim 1, wherein:

the 3D data of the patient is captured in real-time; and

the 3D data of the patient includes video.
4. (Original) The method of claim 1, wherein the outer layer of the patient is a skin layer of the patient.
5. (Original) The method of claim 1, further comprising:

prior to the registering of the real-time position, positioning the patient in a different position as the patient was in when the 3D data of the patient was captured; and

deforming the 3D data to match the different position of the patient.
6. (Previously presented) The method of claim 1, wherein the 3D data includes one or more of Positron Emission Tomography (PET) images, ultrasound images, fluorescence images, Infrared Thermography (IRT) images, and Single-Photon Emission Computed Tomography (SPECT) scan image.

7. (Currently Amended) The method of claim 1, wherein:

the projected inner layer ~~[[of]] of the patient from~~ the 3D data ~~of the patient~~ is colored using a color gradient that represents tissue properties and that is altered to be visible when projected onto the real-time views of the outer layer of the patient; and

the tissue properties include one or more of tissue hardness, relaxivity, echogenicity, enhancement amount, enhancement speed, density, radioactivity, and water content.

8. (Currently Amended) ~~The method of claim 1, wherein:~~ A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

determining virtual morphometric measurements, including size and shape, of the outer layer of the patient from the 3D data;

mapping a 3D space;

registering a real-time position of the outer layer of the patient in the 3D space by mapping the position of the outer layer of the patient within the 3D space;

determining real-time morphometric measurements, including size and shape, of the outer layer of the patient;

~~the method further comprises~~ positioning extra-visual markers on the patient;

automatically registering a virtual position of the outer layer of the patient from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space using the virtual morphometric measurements and using the real-time morphometric measurements;

~~the automatic registering further includes~~ automatically registering the real-time positions of the extra-visual markers with respect to the registered real-time position of the outer layer of the patient in the 3D space;

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient, the real-time views being non-image actual views;

~~the method further comprises~~ covering at least a portion of the patient and the extra-visual markers with an opaque surgical draping;

~~the method further comprises~~ sensing, using a sensor of the AR headset, the real-time positions of the extra-visual markers underneath the opaque surgical draping; and

~~the method further comprises~~ automatically re-registering a virtual position of the outer layer of the patient from the 3D data to align with the sensed real-time positions of the extra-visual markers.

9. (Original) The method of claim 1, wherein the automatic registering is performed using point set registration.

10. (Previously presented) The method of claim 1, further comprising:
generating a numeric confidence score that the automatic registering is correct; and
presenting the numeric confidence score to a user.

11. (Original) One or more non-transitory computer-readable media storing one or more programs that are configured, when executed, to cause one or more processors to perform the method as recited in claim 1.

12. (Currently Amended) A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

mapping a 3D space;

registering a real-time position of the outer layer of the patient in the 3D space by mapping the position of the outer layer of the patient within the 3D space;

registering a virtual position of the outer layer of the patient from the 3D data to align with a real-time position of the outer layer of the patient in a 3D space;

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient, the projected inner layer of the patient from the 3D data being confined within a volume of a virtual spatial difference box, the real-time views being non-image actual views;

determining real-time morphometric measurements, including size and shape, of an object prior to insertion of the object into the patient through the outer layer of the patient;

automatically tracking a real-time position of the object in the 3D space with respect to the registered real-time position of the outer layer of the patient in the 3D space and with respect to the registered virtual position of the outer layer of the patient from the 3D data; and

while a portion of the object is inserted into the patient through the outer layer of the patient, displaying, in the AR headset, a virtual portion of the object projected into the projected inner layer of the patient from the 3D data.

13. (Original) One or more non-transitory computer-readable media storing one or more programs that are configured, when executed, to cause one or more processors to perform the method as recited in claim 12.

14. (Currently Amended) A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient, the projected inner layer of the patient from the 3D data being confined within a volume of a virtual spatial difference box, the real-time views being non-image actual views;

generating, in the AR headset, a virtual user interface that includes options for altering the display of the projected inner layer of the patient from the 3D data;

displaying, in the AR headset, the virtual user interface projected onto real-time views due to a focal orientation of the AR headset not being focused on the patient; and

hiding, in the AR headset, the virtual user interface due to the focal orientation of the AR headset being focused on the patient.

15. (Original) The method of claim 14, further comprising:

displaying, in the AR headset, a virtual cursor projected onto real-time views and/or onto the virtual user interface while a focal orientation of the AR headset is not focused on the patient; and

hiding, in the AR headset, the virtual cursor while a focal orientation of the AR headset is focused on the patient.

16. (Original) The method of claim 14, further comprising:

determining a real-time distance of the patient from the AR headset; and

updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually positioned at a focal distance from the AR headset that is about equal to the real-time distance of the patient from the AR headset.

17. (Original) The method of claim 14, further comprising:

updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually oriented perpendicularly to the focal orientation of the AR headset.

18. (Cancelled)

19. (Currently Amended) The method of claim ~~[[18]]~~ 14, wherein the virtual spatial difference box is configured to selectively display two-dimensional (2D) slices and/or 3D slices of the projected inner layer of the patient from the 3D data.

20. (Original) One or more non-transitory computer-readable media storing one or more programs that are configured, when executed, to cause one or more processors to perform the method as recited in claim 14.

21. (New) The method of claim 1, wherein:

the virtual spatial difference box is configured to be controlled to toggle between displaying and hiding lines of the virtual spatial difference box; and

the virtual spatial difference box is configured to be controlled to reposition two-dimensional (2D) slices and/or 3D slices of the projected inner layer of the patient from the 3D data.

22. (New) The method of claim 1, wherein lines of the of the virtual spatial difference box are displayed.

23. (New) The method of claim 1, wherein lines of the of the virtual spatial difference box are hidden.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/474,702	03/30/2017	Steven Cvetko	N3039.10001US01	9851
97149	7590	11/02/2017		
Maschoff Brennan 1389 Center Drive, Suite 300 Park City, UT 84098			EXAMINER GRAY, RYAN M	
			ART UNIT	PAPER NUMBER
			2611	
			NOTIFICATION DATE	DELIVERY MODE
			11/02/2017	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):

docket@mabr.com
info@mabr.com

Office Action Summary	Application No. 15/474,702	Applicant(s) CVETKO ET AL.	
	Examiner RYAN M. GRAY	Art Unit 2611	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 9/7/17.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ 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.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 1-20 is/are pending in the application.
5a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 6) ☐ Claim(s) ____ is/are allowed.
- 7) ☒ Claim(s) 1-7, 9-17, 19-20 is/are rejected.
- 8) ☒ Claim(s) 8 and 18 is/are objected to.
- 9) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, 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.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ 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)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date ____.
- 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____.
- 4) ☐ Other: ____.

DETAILED ACTION

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to Amendments / Remarks

Applicant's arguments, filed 9/7/17 have been fully considered.

Regarding Applicant's argument (1): The cited prior art uses a video see-through rather than an actual view. The amended subject matter ("non-image actual views") therefore differs from the cited prior art. Applicant's argument is persuasive. Razzaque is cited below to address a see-through display.

Regarding Applicant's argument (2): Applicant's argument is persuasive. Razzaque is cited below to address the amended limitation.

Regarding Applicant's argument (3): Applicant's argument is persuasive. Razzaque is cited below to address the amended limitations.

Regarding Applicant's argument (4): Applicant's argument has been fully considered but is unpersuasive. The broadest reasonable interpretation of focal orientation would include angular thresholds. The disclosure in Jones would encompass programmed thresholds that affect menu display.

Regarding claim 2. Applicant's argument is persuasive. Razzaque is cited below to address the amended subject matter.

Regarding claim 3. Applicant's argument has been fully considered but is unpersuasive. The 3D data would necessarily be real-time as the instrument is represented and used to guide the surgeon (see Maier, ¶ 147)("diving means may be

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employed to determine whether the image of the instrument as acquired by the sensing means coincides with the projected shape or free the representation of said instrument, and may guide the user to align the instrument with its representation. [0150] (3) Guidance: To transfer the planned path to the patient, the physician may follow an augmented reality (AR) view on the guidance monitor. In the intensity image of the camera, he may see the true instrument pose as well as a projected (virtual) second pose that represents a desired pose prior to needle insertion. The task of the physician is to align the instrument with this projection.”)

Regarding claim 5, Applicant’s argument is unpersuasive because the suggested application is to compensate for breathing. Shifting all 3D data would result in misalignment. Additionally, the suggestion provided is to “compensate movement of the surface” (Maier, ¶ 153)

Regarding claim 6. Applicant’s argument is persuasive, additional art is cited below to address the amended subject matter.

Regarding claim 7. Applicant’s argument is unpersuasive. The listed properties are well known in medical imaging. The person of ordinary skill would consider application of color coding for the purpose of indicating various properties and the techniques would be equally applicable to any properties for the same reasons.

Regarding claim 8. Applicant’s argument is persuasive.

Regarding claim 10. Applicant’s argument is persuasive. Additional art is cited below to address the amended subject matter.

Regarding claim 15. Applicant's argument is unpersuasive. The disclosed subject matter in Jones concerns menu and display changes responsive to an angular threshold. The person of ordinary skill would consider assigning different menu interactions when considering the context of the user's viewpoint.

Regarding claim 16. Applicant's argument is unpersuasive because the claim term recites a relative term "about". Jones' system is configurable by the user and positions the screens in a region near the patient.

Regarding claim 17. Applicant's argument is unpersuasive because the techniques disclosed result in an interface that follows the perpendicular.

Regarding claim 18. Applicant's argument is persuasive.

Prior Art

Maier-Hein (US 2013/0245461)

Lee et al. (US 2014/0275760)

Jones et al. (US 2016/0225192)

Bidne et al. (US 2015/0049083)

Wendler (US 2010/0266171)

Razzaque (US Patent 9,675,319)

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having

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ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Claim(s) 1, 3-6, 9, 11-13 is/are rejected under 35 U.S.C. 103 as being unpatentable over by Maier in view of Razzaque

Claim 2 is/are rejected under 35 U.S.C. 103 as being unpatentable over Maier in view of Lee.

Claim 7 is/are rejected under 35 U.S.C. 103 as being unpatentable over Maier in view of Bidne.

Claim 10 is/are rejected under 35 U.S.C. 103 as being unpatentable over Maier in view of Wendler.

Claim 14-17, 19-20 is/are rejected under 35 U.S.C. 103 as being unpatentable over Maier in view of Bidne and Jones.

Claim 1

Maier discloses **a method for augmenting real-time views of a patient with three-dimensional (3D) data** (Fig. 2; ¶ 99: “FIG. 2 schematically illustrates a surface rendering of the medical image data of the patient's knee joint on a display means according to the present invention, wherein the medical image of the knee joint is superimposed with a surface image masking neighbouring body parts”), **the method comprising:**

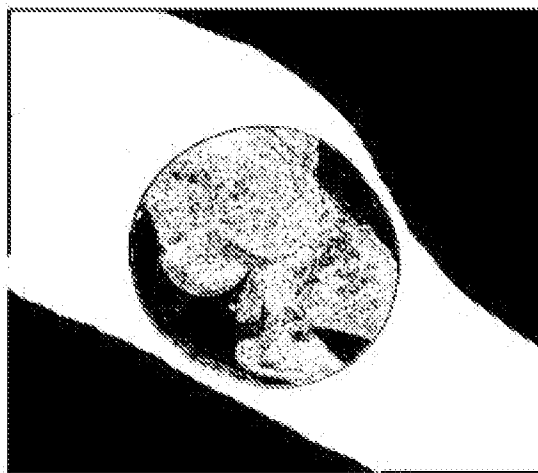


Figure 2

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient (Maier, ¶ 13: “anatomical data relating to said patient may be pre-recorded medical image data of said patient, for instance image data generated from raw data acquired during a CT scan or a MRI scan”);

determining virtual morphometric measurements, including size and shape, of the outer layer of the patient from the 3D data (e.g. creating a surface profile of CT data; Fig. 3; ¶ 113: “Initially, i.e. upon start of the visualization method, a graph-based registration process may be performed to obtain an initial alignment of the surface profile generated from the range image with a surface profile generated from the pre-recorded medical image data.”);

mapping a 3D space;

registering a real-time position of the outer layer of the patient in the 3D space by mapping the position of the outer layer of the patient within the 3D

space (Maier, ¶ 108: “By evaluating the distance information provided by the time-of-flight camera 26, the pose of the time-of-flight camera 26 relative to the surface of the patient 14 may be tracked and may be continuously updated to follow the movements of the display means 22 along the body of the patient 14”);

determining real-time morphometric measurements, including size and shape, of the outer layer of the patient (e.g. creating a surface profile of patient from range data; Fig. 3; ¶ 113: “Initially, i.e. upon start of the visualization method, a graph-based registration process may be performed to obtain an initial alignment of the surface profile generated from the range image with a surface profile generated from the pre-recorded medical image data.”);

automatically registering a virtual position of the outer layer of the patient from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space using the virtual morphometric measurements and using the real-time morphometric measurements (Fig. 3 Registration of ToF surface and CT surface); **and**

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient, ~~the real-time views being non-image actual views~~ (Maier, ¶ 29: “Said display means may comprise...a head-mounted display, or any 3D display”)

Maier does not explicitly disclose, but Razzaque makes obvious **mapping a 3D space** (“The system 101 can the coordinate systems to track and display the various medical devices and images on the displays, including, but not limited to one or more

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position sensing coordinate systems 180A, 180B (generically referred to as 180), one or more room coordinate systems 182, one or more 3D scene coordinate systems 184, one or more display coordinate systems 186, one or more sensor coordinate systems 188A, 188B, one or more medical device coordinate systems 190A, 190B, one or more virtual medical device coordinate systems 192A, 192B, one or more medical image coordinate systems 194, etc.”)

the real-time views being non-image actual views (“Referring now to FIG. 1B, virtual image content may be displayed on a head mounted display (HIVID) 250... displays 252, 254 can be transparent or translucent... can allow the wearer to view the virtual content 253, 255 while also viewing the real environment in the portion of the wearer's field of view unoccupied by displays 252, 254, such as through transparent portions 256, 258 of the HMD 250.”)

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Razzaque's disclosure with Maier. Using a transparent display would have been a simple substitution of one known element (transparent display) for another (an image based see-through). The techniques would be equally applicable to both display types and they would serve the same purpose. The motivation for mapping a 3D space would be to determine the physical location of the patient within the room in order to display augmented content relative to the user's head position and display view.

Claim 2

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The cited prior art further discloses ~~the registering of the real-time position and the determining of the real-time morphometric measurements are accomplished using sensors included in the AR headset; and~~

~~the sensors include one or more of infrared sensors, sound sensors, photographic sensors, fluoroscopy sensors, accelerometers, gyroscopes, and magnetometers~~ (Razzaque, "sensing unit 106 can each be an inertial 3D tracking system comprising a compass, accelerometer, tilt sensor, and/or gyro")

The cited prior art does not disclose, but Lee makes obvious ~~the registering of the real-time position and the determining of the real-time morphometric measurements are accomplished using sensors included in the AR headset~~ (Lee, ¶ 75: "According to the illustrated embodiment, the augmented reality image display system 400 may include a camera 410 that captures a real image including a plurality of markers attached to the patient's body or a human body model, an augmented reality image generator 430 that detects the plurality of markers in the real image acquired by the camera 410, estimates position and gaze direction of the camera 410 using the detected markers, and generates an augmented reality image by overlaying a virtual image of a corresponding region over the real image, and a display 420 that displays the augmented reality image, as illustrated in FIG. 2")

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Lee's teachings to integrate the sensor in a headset. The sensor performs the same function separately and in the integrated version. They could be combined to yield predictable results.

Claim 3

The cited prior art further discloses **the 3D data of the patient is captured in real-time; and the 3D data of the patient includes video** (Maier, ¶¶ 103-05: “The time-of-flight camera 26 is able to generate dense range images and corresponding grayscale intensity images from a given scene in real-time. Its operation principle is generally similar to that of a laser scanner, with the additional advantage that a whole scene may be captured at once. State of the art time-of-flight cameras provide more than 50 images per second...the visualization system 10 also comprises a conventional colour camera (not shown) to provide high resolution colour images of the scene...The visualization system 10 can be employed for on-patient visualization of pre-recorded medical images, such as the medical images provided by the computed tomography scanner 20, or any other medical imaging device suitable for acquiring static 3D images, such as a magnetic resonance imaging (MRI) scanner. Preferably, the medical imaging modality is chosen such that it provides surface information alongside information pertaining to the internal structures of the patient, e.g. a computer tomography scanner or a magnetic resonance imaging scanner. The medical image data may be acquired beforehand and may be recorded and stored, e.g. in the Picture Archiving and Communications System (PACS) of a hospital, from which they may be accessed by the visualization system 10.”)

Claim 4

The cited prior art further discloses **wherein the outer layer of the patient is a skin layer of the patient** (Maier, ¶ 38: “In this configuration, the image on display may

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contain both the visualization of (virtual) medical image data and a physical (real) image of the surface of a patient, such as the patient's skin or clothing.”).

Claim 5

The cited prior art further discloses **prior to the registering of the real-time position, positioning the patient in a different position as the patient was in when the 3D data of the patient was captured; and deforming the 3D data to match the different position of the patient** (e.g. change of surface characteristics from patient chest movement; Maier, ¶ 153: “registration compensate movement of the surface, such as may be caused by breathing, in order to provide a corrected indication of the relative position of the instrument with respect to the anatomical structure. This may compensate for the change of the needle trajectory relative to a patient's skin depending on the breathing state.”).

Claim 6

The cited prior art further discloses **wherein the 3D data includes one or more of Positron Emission Tomography (PET) images, ultrasound images, fluorescence images, Infrared Thermography (IRT) images, and Single-Photon Emission Computed Tomography (SPECT) scan image** (Maier, ¶13: “this case, the anatomical data relating to said patient may be pre-recorded medical image data of said patient, for instance image data generated from raw data acquired during a CT scan or a MRI scan”; Loupe, “In some embodiments, the imaging data obtained from one or both of medical devices 112 and 114 can include other modalities such as a CT scan, MRI, open-magnet MRI, optical coherence tomography (“OCT”), positron emission

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tomography ("PET") scans, fluoroscopy, ultrasound, or other preoperative, or intraoperative 2D or 3D anatomical imaging data. In some embodiments, medical devices 112 and 114 can also be scalpels, implantable hardware, or any other device used in surgery.”).

Claim 7

The cited prior art does not explicitly disclose, but Bidne makes obvious **the projected inner layer of the 3D data of the patient is colored using a color gradient that represents tissue properties and that is altered to be visible when projected onto the real-time views of the outer layer of the patient** (Bidne, ¶ 3: "Typical modern, digital imaging techniques include magnetic resonance imaging (MRI) and computed tomography (CT) scans. In addition to producing images that can be colored for more ready interpretation, such scans can also produce data files that can be automatically analyzed and manipulated in various manners”); **and**

the tissue properties include one or more of tissue hardness, relaxivity, echogenicity, enhancement amount, enhancement speed, density, radioactivity, and water content (Bidne, ¶ 9: "If contact is made, the system may note it, and perform both mechanical and material analysis on any around the points of contact. For example, for mechanical analysis, a system may cause deformation of tissue to occur in the model using finite element analysis techniques, and may also change a display of the model so as to show the tissue moving in response to the stress, and perhaps changing the displayed color of the tissue, where the new colors represent the level of stress or strain on the tissue at particular points. The system may also deform the

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device in response to computed forces from the tissue, and may display the deformed device graphically in an animation and/or generate and save, and display alphanumeric representations of parameters for the forces on the device and the tissue and the deformation of each”).

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Bidne’s teachings in order to color code tissue properties. Identification of tissue properties is well known and could be readily combined with color augmentation to identify specific characteristics to the reviewer.

Claim 9

The cited prior art further discloses **wherein the automatic registering is performed using point set registration** (Maier, ¶118: “Point-based registration: Based on the knowledge of the camera parameters, a surface profile may be generated from the range image and/or intensity image of the time-of-flight camera 26. A further surface profile may be extracted from the 3D medical data set. Both the surface profile generated from the time-of-flight camera 26 and the surface profile extracted from the 3D medical data set may be converted into point clouds”).

Claim 10

The cited prior art does not explicitly disclose, but Wendler makes obvious **generating a numeric confidence score that the automatic registering is correct; and presenting the numeric confidence score to a user** (Wendler, ¶ 219: “A method for intra-operative 3D-nuclear imaging, 3D-visualization and image-guided surgery, based on pre-operative data and tracked radiation detectors as described in any of the

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preceding or following embodiments, further including: (a) online computation or tracking of errors in the position and orientation of any of the tracked objects and/or of the error in the reading of the radiation display; and (b) displaying the error for a signing a level of confidence to the readings”)

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Wendler’s teachings to indicate confidence score. The motivation would have been to inform the user of the accuracy of the registration.

Claim 11

The same teachings and rationales in claim 1 are applicable to claim 11.

Claim 12

The same teachings and rationales in claim 1 are applicable to claim 12.

The cited prior art additionally discloses: **automatically tracking a real-time position of the object in the 3D space with respect to the registered real-time position of the outer layer of the patient in the 3D space and with respect to the registered virtual position of the outer layer of the patient from the 3D data; and while a portion of the object is inserted into the patient through the outer layer of the patient, displaying, in the AR headset, a virtual portion of the object projected into the projected inner layer of the patient from the 3D data** (Maier, ¶ 58: “The object may be an instrument such as a medical or surgical instrument, or any other kind of object that shall be placed at a predetermined position relative to said subject and/or shall be moved along a predetermined trajectory relative to said subject. Said position may be a position above or besides a surface of said subject, or may be a position in

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the interior of said subject. In the same way, said trajectory may be a trajectory extending above or besides the surface of said subject, or may extend partly in or through said subject. In particular, said trajectory may extend partly externally and partly internally with respect to said subject. For instance, said trajectory may be an insertion path such as a predetermined path along which a physician may want to insert a needle through the surface of the patient and to move the tip of said needle to a predetermined body part. The position of the surface relative to the anatomical structures may vary over time, such as if a patient breathes while being examined. The visualization means may be adapted to monitor, display and/or compensate this surface movement.”).

The cited prior art further discloses: **determining real-time morphometric measurements, including size and shape, of an object prior to insertion of the object into the patient through the outer layer of the patient** (“In some embodiments, the display of the virtual medical device can be based at least in part on dimensions of a corresponding real medical device (non-limiting examples: size, shape, or other appearance).”).

Claim 13

The same teachings and rationales in claim 12 are applicable to claim 13.

Claim 14

The same teachings and rationales in claim 1 are applicable to claim 14.

The cited prior art does not disclose, Bidne makes obvious **generating, in the AR headset, a virtual user interface that includes options for altering the display**

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of the projected inner layer of the patient from the 3D data (Fig. 1; ¶ 27: “along with a number of menu selections made available to the user 110. For example, one or more lines may be presented on the touch tablet 106, and a user may slide the lines across the touch tablet 106 by touching the end of a particular line and dragging in contact with the screen of the touch tablet 106. Such dragging may cause a line to intersect a 3D or 3D representation of the model, and may cause the computer system 104 to apply a cutting plane to the model so that the user 110 can see an interior portion of the model.”);

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Bidne's teachings in order to use a menu. The motivation would have been to allow the user to configure the display.

The cited combination does not explicitly disclose, but Jones makes obvious **displaying, in the AR headset, the virtual user interface projected onto real-time views due to a focal orientation of the AR headset not being focused on the patient, the real-time views being non-image actual views** (Jones, ¶ 71: “FIG. 11 illustrates operations triggered by when the surgeon's head tilts up above the first pitch threshold and below a second pitch threshold so the surgeon's line-of-sight is along line 704 through the display screen 752. The primary virtual display panel 710 disappears from the display screen 752 and the three video streams (e.g., HDMI channels B, C and D) become separately viewable or at least partially collectively viewable as the three secondary virtual display panels 720, 722, and 724 floating in space. These secondary virtual display panels 720, 722, and 724 may first appear at default radial positions on a

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sphere centered in the surgeon's head, but the surgeon can have the ability to reposition and resize them for maximum convenience.”; Non image actual views from claim 1); **and**

hiding, in the AR headset, the virtual user interface due to the focal orientation of the AR headset being focused on the patient (Fig. 10; ¶ 70: " In the example of FIG. 10, the surgeon's head is tilted downward below the first pitch threshold so that the surgeon's line-of-sight 702 is toward the operation site while looking through the TTL loupe. The surgeon may shift eye position upward so that the surgeon's line-of-sight 700 now looks through the display screen 752. The computer equipment 620 responds to the surgeon's head tilted below the first pitch threshold by operating in the full-screen operational mode to select a defined one of the video streams which it displays on the display screen 752 to generate the primary virtual display panel 710").

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Jones in order to respond to a focal orientation. The motivation would have been to allow hands free configuration.

Claim 15

The cited prior art further makes obvious **displaying, in the AR headset, a virtual cursor projected onto real-time views and/or onto the virtual user interface while a focal orientation of the AR headset is not focused on the patient; and hiding, in the AR headset, the virtual cursor while a focal orientation of the AR headset is focused on the patient** (use of a cursor is a well-known user interface technique (e.g. Jones, ¶ 74) and could be combined with Jones's focus based user

interface. The benefit would have been use of pointing indicator and displaying the user interface when the user looks up)

Claim 16

The cited prior art further makes obvious **determining a real-time distance of the patient from the AR headset; and updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually positioned at a focal distance from the AR headset that is about equal to the real-time distance of the patient from the AR headset** (Jones, ¶ 67: “The example embodiments of FIGS. 10-12 allow a surgeon or other user to see several virtual displays of different medical information without looking away from the surgical site and focusing far away to view physical monitors that may be mounted across the OR or elsewhere adjacent to the patient. In some embodiments, three operational “modes” of the virtual displays are selectively activated based upon pitch of the surgeon's head and the corresponding viewing line-of-sight of the user”)

Claim 17

The cited prior art further discloses **updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually oriented perpendicularly to the focal orientation of the AR headset** (Jones, Figs. 10-12, video views follow direction of sight).

Claim 19

The cited prior art further makes obvious **wherein the virtual spatial difference box is configured to selectively display two-dimensional (2D) slices and/or 3D slices of the projected inner layer of the patient from the 3D data** (Maier, ¶ 132: “In a slice view, the pose of the time-of-flight camera 26 may be used to reconstruct an image slice whose normal direction is given by the viewing direction of the time-of-flight camera 26, and whose depth is derived from the proximity of the camera 26 to the patient's surface”).

Claim 20

The same teachings and rationales in claim 14 are applicable to claim 20.

Allowable Subject Matter

Claims 8, 18 objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not

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mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to RYAN M. GRAY whose telephone number is (571)272-4582. The examiner can normally be reached on Monday through Friday, 9:00 am - 5:00 pm.

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, Kee Tung can be reached on (571) 272-7794. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2611

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.

/RYAN M GRAY/

Primary Examiner, Art Unit 2611

Notice of References Cited	Application/Control No. 15/474,702		Applicant(s)/Patent Under Reexamination CVETKO ET AL.	
	Examiner RYAN M. GRAY		Art Unit 2611	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-9,675,319 B1	06-2017	Razzaque; Sharif	A61B8/0841	1/1
*	B	US-2010/0266171 A1	10-2010	Wendler; Thomas	G01T1/161	382/128
	C	US-				
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	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Steven Cvetko	Art Unit 2611
Application No.:	15/474,702	
Filed:	March 30, 2017	
Conf. No.:	9851	
For:	AUGMENTING REAL-TIME VIEWS OF A PATIENT WITH THREE-DIMENSIONAL DATA	
Examiner:	Ryan M. Gray	
Customer No.:	97149	
Attorney Docket No.:	N3039.10001US01	

AMENDMENT AND RESPONSE TO OFFICE ACTION

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Nonfinal Office Action dated June 7, 2017 (the “Office Action”), please consider the following:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 10 of this paper.

AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions and listings of claims in the application:

1. (Currently Amended) A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

determining virtual morphometric measurements, including size and shape, of the outer layer of the patient from the 3D data;

mapping a 3D space;

registering a real-time position of the outer layer of the patient in [[a]] the 3D space by mapping the position of the outer layer of the patient within the 3D space;

determining real-time morphometric measurements, including size and shape, of the outer layer of the patient;

automatically registering a virtual position of the outer layer of the patient from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space using the virtual morphometric measurements and using the real-time morphometric measurements; and

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient, the real-time views being non-image actual views.

2. (Currently Amended) The method of claim 1, ~~where~~ wherein:

the registering of the real-time position and the determining of the real-time morphometric measurements are accomplished using sensors included in the AR headset; and

the sensors include one or more of infrared sensors, sound sensors, ~~photographic sensors~~, fluoroscopy sensors, accelerometers, gyroscopes, and magnetometers.

3. (Original) The method of claim 1, wherein:

the 3D data of the patient is captured in real-time; and

the 3D data of the patient includes video.

4. (Original) The method of claim 1, wherein the outer layer of the patient is a skin layer of the patient.

5. (Original) The method of claim 1, further comprising:

prior to the registering of the real-time position, positioning the patient in a different position as the patient was in when the 3D data of the patient was captured; and

deforming the 3D data to match the different position of the patient.

6. (Currently Amended) The method of claim 1, wherein the 3D data includes one or more of ~~MRI images, Computerized Tomography (CT) scan images, X-ray images~~, Positron Emission Tomography (PET) images, ultrasound images, fluorescence images, Infrared Thermography (IRT) images, and Single-Photon Emission Computed Tomography (SPECT) scan image.

7. (Original) The method of claim 1, wherein:

the projected inner layer of the 3D data of the patient is colored using a color gradient that represents tissue properties and that is altered to be visible when projected onto the real-time views of the outer layer of the patient; and

the tissue properties include one or more of tissue hardness, relaxivity, echogenicity, enhancement amount, enhancement speed, density, radioactivity, and water content.

8. (Currently Amended) The method of claim 1, wherein:

the method further comprises positioning extra-visual markers on the patient;

the automatic registering further ~~include~~ includes automatically registering the real-time positions of the extra-visual markers with respect to the registered real-time position of the outer layer of the patient in the 3D space;

the method further comprises covering at least a portion of the patient and the extra-visual markers with an opaque surgical draping;

the method further comprises sensing, using a sensor of the AR headset, the real-time positions of the extra-visual markers underneath the opaque surgical draping; and

the method further comprises automatically re-registering a virtual position of the outer layer of the patient from the 3D data to align with the sensed real-time positions of the extra-visual markers.

9. (Original) The method of claim 1, wherein the automatic registering is performed using point set registration.

10. (Currently Amended) The method of claim 1, further comprising:
- generating a numeric confidence score that the automatic registering is correct; and
- presenting the numeric confidence score to a user.
11. (Original) One or more non-transitory computer-readable media storing one or more programs that are configured, when executed, to cause one or more processors to perform the method as recited in claim 1.

12. (Currently Amended) A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

mapping a 3D space;

registering a real-time position of the outer layer of the patient in the 3D space by mapping the position of the outer layer of the patient within the 3D space;

registering a virtual position of the outer layer of the patient from the 3D data to align with a real-time position of the outer layer of the patient in a 3D space;

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient, the real-time views being non-image actual views;

determining real-time morphometric measurements, including size and shape, of an object prior to insertion of the object into the patient through the outer layer of the patient;

automatically tracking a real-time position of the object in the 3D space with respect to the registered real-time position of the outer layer of the patient in the 3D space and with respect to the registered virtual position of the outer layer of the patient from the 3D data; and

while a portion of the object is inserted into the patient through the outer layer of the patient, displaying, in the AR headset, a virtual portion of the object projected into the projected inner layer of the patient from the 3D data.

13. (Original) One or more non-transitory computer-readable media storing one or more programs that are configured, when executed, to cause one or more processors to perform the method as recited in claim 12.

14. (Currently Amended) A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient, the real-time views being non-image actual views;

generating, in the AR headset, a virtual user interface that includes options for altering the display of the projected inner layer of the patient from the 3D data;

displaying, in the AR headset, the virtual user interface projected onto real-time views ~~while~~ due to a focal orientation of the AR headset ~~[[is]]~~ not being focused on the patient; and

hiding, in the AR headset, the virtual user interface ~~while~~ due to the focal orientation of the AR headset ~~[[is]]~~ being focused on the patient.

15. (Original) The method of claim 14, further comprising:

displaying, in the AR headset, a virtual cursor projected onto real-time views and/or onto the virtual user interface while a focal orientation of the AR headset is not focused on the patient; and

hiding, in the AR headset, the virtual cursor while a focal orientation of the AR headset is focused on the patient.

16. (Original) The method of claim 14, further comprising:

determining a real-time distance of the patient from the AR headset; and

updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually positioned at a focal distance from the AR headset that is about equal to the real-time distance of the patient from the AR headset.

17. (Original) The method of claim 14, further comprising:

updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually oriented perpendicularly to the focal orientation of the AR headset.

18. (Original) The method of claim 14, further comprising:

displaying, in the AR headset, a virtual spatial difference box projected onto real-time views of the patient, the virtual spatial difference box confining within a volume of the virtual spatial difference box the projected inner layer of the patient from the 3D data.

19. (Original) The method of claim 18, wherein the virtual spatial difference box is configured to selectively display two-dimensional (2D) slices and/or 3D slices of the projected inner layer of the patient from the 3D data.

20. (Original) One or more non-transitory computer-readable media storing one or more programs that are configured, when executed, to cause one or more processors to perform the method as recited in claim 14.

REMARKS

The paper is in response to the Office Action. The foregoing amendment amends claims 1, 2, 6, 8, 10, 12, and 14. Claims 1-20 remain pending. Applicants respectfully request reconsideration of the application in view of the above amendments to the claims and the following remarks. For Examiner's convenience and reference, Applicants present remarks in the order that the Office Action raises the corresponding issues.

In connection with the prosecution of this case and any related cases, Applicants have, and/or may, discuss various aspects of the disclosure of the cited references as those references are then understood by Applicants. Because such discussion could reflect an incomplete or incorrect understanding of one or more of the references, the position of Applicants with respect to a reference is not necessarily fixed or irrevocable. Applicants thus hereby reserve the right, both during and after prosecution of this case, to modify the views expressed with regard to any reference.

Please note that Applicants do not intend the following remarks to be an exhaustive enumeration of the distinctions between any cited references and the claims. Rather, Applicants present the distinctions below solely by way of example to illustrate some of the differences between the claims and the cited references. Finally, Applicants request that Examiner carefully review any references discussed below to ensure that Applicants' understanding and discussion of any reference is consistent with Examiner's understanding.

Unless otherwise explicitly stated, the term "Applicants" is used herein generically and may refer to a single inventor, a set of inventors, an appropriate assignee, or any other entity or person with authority to prosecute this application.

Examiner's Interview

Applicants thank Examiner for the telephone interview of August 22, 2017 (the "Interview"). The amendments and remarks herein reflect the substance of the Interview.

Rejections Under 35 U.S.C. § 102 and § 103

The Office Action rejects claims 1, 3-6, 9, 11-13 under 35 U.S.C. § 102(a)(1) over Maier-Hein (U.S. Publication No. 2013/0245461). The Office Action also rejects claim 2 under 35 U.S.C. § 103(a) over Maier in view of Lee (U.S. Publication No. 2014/0275760). The Office Action also

rejects claim 7 under 35 U.S.C. § 103(a) over Maier in view of Bidne (U.S. Publication No. 2015/0049083). The Office Action also rejects claim 8 under 35 U.S.C. § 103(a) over Maier in view of Lee and Jones (U.S. Publication No. 2016/0225192). The Office Action also rejects claim 10 under 35 U.S.C. § 103(a) over Maier in view of Yang (U.S. Publication No. 2013/0060146). The Office Action also rejects claims 14-20 under 35 U.S.C. § 103(a) over Maier in view of Bidne and Jones.

a. independent claims 1, 12, and 14

Applicants do not necessarily agree with Examiner's statements regarding at least (1) whether the cited reference(s) disclose each and every element recited in the claims, (2) whether the cited reference(s) teach the combination presented in the claims, (3) whether the cited reference(s) disclose or inherently include the features that the Office Action asserts that the reference(s) include, and (4) whether the reference(s) or any other source provide a reason to combine the teachings of the reference(s).

Nevertheless, in the interest of expediting prosecution, Applicants have herein amended independent claims 1, 12, and 14 to further clarify the claimed inventions, as discussed in the Interview.

(1) “the real-time views being non-image actual views”

Each of independent claims 1, 12, and 14 is amended herein to recite “displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto *real-time views* of the outer layer of the patient, *the real-time views being non-image actual views*.” Support for these amendments can be found at least in paragraphs [0019] and [0036]-[0038] of the specification where a distinction is made between an *actual* view (e.g., a view of the patient that can be viewed with the naked eye of the user or with the eye of the user through a lens of an AR headset) and *images* (such as *video* images) of the actual view that “may be captured by the AR headset 108 and then sent to a remote location.”

As discussed in the Interview, the pre-amendment version of this limitation is rejected in the Office Action over paragraph [0029] of Maier. *See* Office Action, page 5. Although Maier does disclose use of a “head-mounted display” in paragraph [0029], this head-mounted display does *not* appear to project “3D data onto ... *non-image* actual views” as recited in amended independent

claims 1, 12, and 14. Instead, Maier only appears to teach taking an *image* of the patient, and then projecting anatomical data onto this *image*. See Maier, paragraphs [0036]-[0038] (“By displaying the surface *image* together with the anatomical data, a very intuitive visualization can be achieved...”). Further, none of the other cited references are cited as teaching the pre-amendment version of this limitation.

Therefore, the cited references, either alone or in combination, do not appear to teach this amended limitation of independent claims 1, 12, and 14. Applicants therefore respectfully request that Examiner withdraw the rejections under 35 U.S.C. §102 and §103 of independent claims 1, 12, and 14 and of claims 1-11, 13, and 15-20 which depend therefrom.

(2) “mapping the position ... of the patient within the 3D space”

Each of independent claims 1 and 12 is amended herein to recite “mapping a 3D space” and “registering a real-time position of the outer layer of the patient in the 3D space by mapping the position of the outer layer of the patient within the 3D space.” Support for these amendments can be found at least in paragraph [0057] of the specification.

As discussed in the Interview, the pre-amendment version of this limitation is rejected in the Office Action over paragraph [0108] of Maier. See Office Action, pages 4-5. Although this cited portion of Maier does disclose tracking “the pose of the time-of-flight *camera 26 relative to* the surface of the *patient 14*,” Maier does *not* appear to teach tracking the position of the patient by “*mapping the position ... of the patient within the 3D space*” as recited in amended claims 1 and 12. Tracking a patient “by *mapping the position ... of the patient within the 3D space*” is patentably distinct from tracking a patient *relative to a camera*. Further, none of the other cited references are cited as teaching the pre-amendment version of this limitation.

Therefore, the cited references, either alone or in combination, do not appear to teach this amended limitation of independent claims 1 and 12. For these additional reasons, Applicants therefore respectfully request that Examiner withdraw the rejections under 35 U.S.C. §102 and §103 of claims 1 and 12 and claims 1-11 and 13 which depend therefrom.

(3) “determining ... size and shape ... of an object”

Independent claim 12 is amended herein to recite “determining real-time morphometric measurements, including *size and shape*, of an object prior to insertion of the object into the patient

through the outer layer of the patient.” Support for these amendments can be found at least in paragraphs [0058] and [0062] of the specification.

As discussed in the Interview, the pre-amendment version of this limitation does not appear to be discussed in the Office Action. *See* Office Action, pages 12-13. Although Maier does disclose use of an object (such as a surgical instrument) in paragraph [0058], and discusses measuring a distance between a sensor and a surface of the object in paragraph [0060], Maier does *not* appear to teach “determining real-time morphometric measurements, including *size and shape*, of [the] object” as recited in amended independent claim 12. Further, none of the other cited references are cited as teaching the pre-amendment version of this limitation.

Therefore, the cited references, either alone or in combination, do not appear to teach this amended limitation of independent claim 12. For these additional reasons, Applicants therefore respectfully request that Examiner withdraw the rejections under 35 U.S.C. §102 of claim 12 and of claim 13 which depends therefrom.

(4) “hiding ... the virtual user interface due to ... the AR headset being focused on the patient”

Independent claim 14 is amended herein to recite “displaying, in the AR headset, the virtual user interface projected onto real-time views due to a focal orientation of the AR headset not being focused on the patient” and “hiding, in the AR headset, the virtual user interface due to the focal orientation of the AR headset being focused on the patient.” Support for these amendments can be found at least in paragraphs [0040] and [0067]-[0068] of the specification.

As discussed in the Interview, the pre-amendment version of these limitations are rejected in the Office Action over paragraphs [0070]-[0071] of Jones. *See* Office Action, pages 14-15. Although Jones does disclose, in paragraphs [0070]-[0071], changing from a primary virtual display panel 710 to three video streams when the headset is *tilted upward*, this is patentably distinct from displaying or hiding a virtual user interface depending on whether the AR headset is *focused on the patient*, as recited in amended claim 14. For example, where a patient is positioned above the headset, looking up at the patient wearing the headset of Jones will cause the display of the three video streams of Jones to be overlaid over the top of the patient. Jones does *not* appear to keep track of the location of the patient and hide a virtual user interface *when the focus of the*

headset is on the patient, but instead appears to hide or display the three video streams based on the *tilt* of the headset.

Therefore, the cited references, either alone or in combination, do not appear to teach this amended limitation of independent claim 14. For these additional reasons, Applicants therefore respectfully request that Examiner withdraw the rejections under 35 U.S.C. §102 of claim 14 and of claims 15-20 which depend therefrom.

b. dependent claim 2

In addition to the foregoing, the rejection of dependent claim 2 suffers from additional deficiencies. Dependent claim 2 is amended herein to recite that “the sensors include one or more of *infrared sensors, sound sensors, fluoroscopy sensors, accelerometers, gyroscopes, and magnetometers.*” The pre-amendment version of this limitation is rejected in the Office Action over paragraph [0065] of Maier. *See* Office Action, pages 5-6. However, this cited portion of Maier does not appear to teach any of “infrared sensors, sound sensors, fluoroscopy sensors, accelerometers, gyroscopes, and magnetometers” as recited in amended claim 2. Therefore, the rejection under 35 U.S.C. §102 of claim 2 should be withdrawn for this additional reason.

c. dependent claim 3

In addition to the foregoing, the rejection of dependent claim 3 suffers from additional deficiencies. Dependent claim 3 recites that “the 3D data of the patient is *captured in real-time*” and “the 3D data of the patient includes *video*.” These limitations are rejected in the Office Action over paragraphs [0103]-[0105] of Maier. *See* Office Action, pages 6-7. However, this cited portion of Maier appears to teach “*static* 3D images” instead of “3D data [that] includes *video*” as recited in claim 3. Further, this cited portion of Maier appears to teach 3D images that are “*prerecorded*” and “acquired *beforehand*” instead of being “3D data [that] is *captured in real-time*” as recited in claim 3. Therefore, the rejection under 35 U.S.C. §102 of claim 3 should be withdrawn for these additional reasons.

e. dependent claim 5

In addition to the foregoing, the rejection of dependent claim 5 suffers from additional deficiencies. Dependent claim 5 recites “prior to the registering of the real-time position, positioning the patient in a different position as the patient was in when the 3D data of the patient

was captured” and “deforming the 3D data to match the different position of the patient.” These limitations are rejected in the Office Action over paragraph [0153] of Maier. *See* Office Action, pages 7-8. However, this cited portion of Maier appears to teach **shifting** 3D data because the patient moved instead of “**deforming** the 3D data to match the different position of the patient” as recited in claim 5. **Deforming** 3D data is patentably distinct from simply **shifting** 3D data from one position to another. Therefore, the rejection under 35 U.S.C. §102 of claim 5 should be withdrawn for this additional reason.

f. dependent claim 6

In addition to the foregoing, the rejection of dependent claim 6 suffers from additional deficiencies. Dependent claim 6 is amended herein to recite that “the 3D data includes one or more of **Positron Emission Tomography (PET) images, ultrasound images, fluorescence images, Infrared Thermography (IRT) images, and Single-Photon Emission Computed Tomography (SPECT) scan image.**” The pre-amendment version of this limitation is rejected in the Office Action over paragraph [0013] of Maier. *See* Office Action, page 8. However, this cited portion of Maier does **not** appear to teach any of “Positron Emission Tomography (PET) images, ultrasound images, fluorescence images, Infrared Thermography (IRT) images, and Single-Photon Emission Computed Tomography (SPECT) scan image” as recited in amended claim 6. Therefore, the rejection under 35 U.S.C. §102 of claim 6 should be withdrawn for this additional reason.

g. dependent claim 7

In addition to the foregoing, the rejection of dependent claim 7 suffers from additional deficiencies. Dependent claim 7 recites that “the tissue properties include one or more of **tissue hardness, relaxivity, echogenicity, enhancement amount, enhancement speed, density, radioactivity, and water content.**” This limitation is rejected in the Office Action over paragraph [0003] of Bidne. *See* Office Action, pages 8-9. Although this cited portion of Bidne appears to teach color coding for the “level of **stress or strain** on the tissue at particular points,” this teaching on a level of **stress or strain** does **not** appear to anticipate or render obvious any of “tissue hardness, relaxivity, echogenicity, enhancement amount, enhancement speed, density, radioactivity, and water content” as recited in claim 7. In particular, “**stress or strain**” on a tissue appear to be patentably distinct from each of the tissue properties recited in claim 7. Therefore, the rejection under 35 U.S.C. §103 of claim 7 should be withdrawn for this additional reason.

h. dependent claim 8

In addition to the foregoing, the rejection of dependent claim 8 suffers from additional deficiencies. Dependent claim 8 recites that “the method further comprises ***covering*** at least a portion of the patient and the extra-visual markers ***with an opaque surgical draping***” and “the method further comprises sensing, using a sensor of the AR headset, the real-time positions of the extra-visual markers ***underneath the opaque surgical draping***.” These limitations are rejected in the Office Action over paragraph [0101] of Jones. *See* Office Action, pages 10-11. Although this cited portion of Jones appears to teach X-ray imagery data of markers, this teaching does ***not*** appear to teach or suggest anything regarding an “***opaque surgical draping***” or regarding “sensing, using a sensor of the AR headset, the real-time positions of the extra-visual markers ***underneath the opaque surgical draping***” as recited in claim 8. This rejection of claim 8 is clearly not a *prima facie* rejection given the complete absence of any teaching in the cited portion of Jones of any “***opaque surgical draping***” as recited in claim 8. Therefore, the rejection under 35 U.S.C. §103 of claim 8 should be withdrawn for this additional reason.

i. dependent claim 10

In addition to the foregoing, the rejection of dependent claim 10 suffers from additional deficiencies. Dependent claim 10 is amended herein to recite “presenting the ***numeric*** confidence score to a user.” The pre-amendment version of this limitation is rejected in the Office Action over paragraphs [0157]-[0158] of Yang. *See* Office Action, page 8. Although this cited portion of Yang does appear to teach a “confidence criteria” and that if the confidence criteria is not met, “a prompt ... such as a beep ... text or flashing icon on a display” may be presented to a user, this cited portion of Yang does ***not*** appear to teach “presenting [a] ***numeric*** confidence score to a user” as recited in amended claim 10. Therefore, the rejection under 35 U.S.C. §103 of claim 10 should be withdrawn for this additional reason.

j. dependent claim 15

In addition to the foregoing, the rejection of dependent claim 15 suffers from additional deficiencies. Dependent claim 15 recites “***displaying***, in the AR headset, a virtual cursor projected onto real-time views and/or onto the virtual user interface ***while*** a focal orientation of ***the AR headset is not focused on the patient***” and “***hiding***, in the AR headset, the virtual cursor ***while*** a focal orientation of ***the AR headset is focused on the patient***.” These limitations are rejected in

the Office Action over paragraph [0074] of Jones. *See* Office Action, page 15. Although this cited portion of Jones teaches a “graphical indicia (e.g., crosshair or other reticle) that can be positioned within a presently viewed one of the display panels,” this graphical indicia in Jones does not appear to be ***displayed*** or ***hidden*** depending on whether the focal orientation is ***focused on the patient***. Therefore, the rejection under 35 U.S.C. §103 of claim 15 should be withdrawn for this additional reason.

k. dependent claim 16

In addition to the foregoing, the rejection of dependent claim 16 suffers from additional deficiencies. Dependent claim 16 recites “updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be ***continually positioned at a focal distance*** from the AR headset that is about ***equal to the real-time distance*** of the patient from the AR headset.” This limitation is rejected in the Office Action over paragraph [0067] of Jones. *See* Office Action, pages 15-16. Although this cited portion of Jones does teach the ability to view “virtual displays ... without looking away from the surgical site,” the above-cited limitation of claim 16 is patentably distinct from this teaching of Jones for at least two reasons. First, since claim 16 depends from claim 14, claim 16 requires that the virtual user interface be displayed when the AR headset is not focused on the patient (which would be the location of the surgical site), but this limitation does not appear to be taught in this cited portion of Jones. Second, claim 16 requires that the “focal distance” distance of the virtual user interface to be continually updated to match the “real-time distance of the patient from the AR headset” (such as when the AR headset is moved closer to or further from the patient), but this does not appear to be taught in this cited portion of Jones. Therefore, the rejection under 35 U.S.C. §103 of claim 16 should be withdrawn for this additional reason.

l. dependent claim 17

In addition to the foregoing, the rejection of dependent claim 17 suffers from additional deficiencies. Dependent claim 17 recites “updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually oriented ***perpendicularly*** to the focal orientation of the AR headset.” This limitation is rejected in the Office Action over FIGS. 10-12 of Jones. *See* Office Action, page 16. However, FIGS. 10-12 of Jones appear to illustrate each display tilted back at the top, and thus these displays of Jones are not

“oriented perpendicularly” to the headset as recited in claim 17. Further, the displays in FIGS. 10-12 of Jones appear to **turn on and off** depending on the tilt of the headset, but none of these displays appears to continually **update its orientation** to be “oriented perpendicularly” to the focal origination of the headset as recited in claim 17. In other words, claim 17 requires the orientation of the user interface to **update** with the updating orientation of the AR headset, but the displays in FIGS. 10-12 appear to only **turn on and off** as the tilt of the headset changes. Therefore, the rejection under 35 U.S.C. §103 of claim 17 should be withdrawn for this additional reason.

m. dependent claim 18

In addition to the foregoing, the rejection of dependent claim 18 suffers from additional deficiencies. Dependent claim 18 recites a “virtual spatial difference **box** projected onto real-time views of the patient, the virtual spatial difference box confining within a **volume** of the virtual spatial difference box the projected inner layer of the patient from the 3D data.” This limitation is rejected in the Office Action over paragraph [0132] of Maier. *See* Office Action, page 16. However, this cited portion of Maier only appears to discuss a “slice” with a normal direction and a depth, which appears to be a **two-dimensional slice** that has no **volume**, which is patentably distinct from a “virtual spatial difference **box**” as recited in claim 18, which is **three-dimensional** and is expressly recited in claim 18 to have a “**volume**.” Therefore, the rejections under 35 U.S.C. §103 of claim 18, and of claim 19 which depends therefrom, should be withdrawn for this additional reason.

Charge Authorization

The Commissioner is hereby authorized to charge payment of any of the following fees that may be applicable to this communication, or credit any overpayment, to Deposit Account No. 50-5394: (1) any filing fees required under 37 C.F.R. § 1.16; (2) any patent application and reexamination processing fees under 37 C.F.R. § 1.17; and/or (3) any post issuance fees under 37 C.F.R. § 1.20. In addition, if any additional extension of time is required, which has not otherwise been requested, please consider this a petition therefor and charge any additional fees that may be required to Deposit Account No. 50-5394.

CONCLUSION

In view of the foregoing, and consistent with the discussion during the Interview, Applicants submit that the pending claims are allowable. In the event that Examiner finds remaining impediment to a prompt allowance of this application that may be clarified through a telephone interview or overcome by an Examiner's Amendment, Examiner is requested to contact the undersigned attorney.

Dated this 7th day of September, 2017.

Respectfully submitted,

/John T. Gadd/

JOHN T. GADD

Registration No. 52,928

Attorney for Applicants

Customer No. 97149

Telephone No. (435) 252-1360



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/474,702	03/30/2017	Steven Cvetko	N3039.10001US01	9851
97149	7590	08/28/2017		
Maschoff Brennan 1389 Center Drive, Suite 300 Park City, UT 84098			EXAMINER GRAY, RYAN M	
			ART UNIT	PAPER NUMBER
			2611	
			NOTIFICATION DATE	DELIVERY MODE
			08/28/2017	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):

docket@mabr.com
info@mabr.com

<i>Applicant-Initiated Interview Summary</i>	Application No. 15/474,702	Applicant(s) CVETKO ET AL.	
	Examiner RYAN M. GRAY	Art Unit 2611	

All participants (applicant, applicant's representative, PTO personnel):

(1) RYAN M. GRAY. (3)_____.

(2) JOHN T. GADD. (4)_____.

Date of Interview: 22 August 2017.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.

If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☐Others

(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1 and 12.

Identification of prior art discussed: _____.

Substance of Interview

(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Applicant's representative discussed the scope of real-time view and whether video see through falls under the same scope. Discussed potential amendments to incorporate a transparent display such as Holo lens. Maier does not appear to disclose this feature explicitly

Discussed a reference coordinate system for the room as a potential proposed amendment. Maier appears to orient the content using only position determined relative to the patient.

Discussed determining dimensions of the surgical instrument and rendering a virtual portion within the patient. Maier, ¶ 143 appears to suggest rendering a virtual portion based on dimensions.

Discussed amendments defining the focal orientation based on whether the patient is in view and enabling/disabling the menu based on that. Cited prior art uses angular thresholds and would not accomplish the same menu triggers when the surgeon moves for example.

No agreement was reached as to allowable subject matter.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☒ Attachment

/RYAN M GRAY/ Primary Examiner, Art Unit 2611	
--	--

U.S. Patent and Trademark Office
PTOL-413 (Rev. 8/11/2010)

Interview Summary

Paper No. 20170822

Summary of Record of Interview Requirements**Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record**

A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews

Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.

All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

- 1) A brief description of the nature of any exhibit shown or any demonstration conducted,
- 2) an identification of the claims discussed,
- 3) an identification of the specific prior art discussed,
- 4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
- 5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
- 6) a general indication of any other pertinent matters discussed, and
- 7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/474,702	03/30/2017	Steven Cvetko	N3039.10001US01	9851

97149 7590 06/07/2017
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

EXAMINER

GRAY, RYAN M

ART UNIT	PAPER NUMBER
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2611

NOTIFICATION DATE	DELIVERY MODE
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06/07/2017

ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

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Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docket@mabr.com
info@mabr.com

Office Action Summary	Application No. 15/474,702	Applicant(s) CVETKO ET AL.	
	Examiner RYAN M. GRAY	Art Unit 2611	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 3/30/17.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ 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.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 1-20 is/are pending in the application.
5a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 6) ☐ Claim(s) ____ is/are allowed.
- 7) ☒ Claim(s) 1-20 is/are rejected.
- 8) ☐ Claim(s) ____ is/are objected to.
- 9) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, 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.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☒ The drawing(s) filed on 3/30/17 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ 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)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) ☒ Notice of References Cited (PTO-892) | 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date ____. | 4) ☐ Other: ____. |

DETAILED ACTION

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Maier-Hein (US 2013/0245461)

Lee et al. (US 2014/0275760)

Jones et al. (US 2016/0225192)

Bidne et al. (US 2015/0049083)

Yang et al. (US 2013/0060146)

Claim Rejections - 35 USC § 102 / 103

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Claim(s) 1, 3-6, 9, 11-13 is/are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Maier

Claim 2 is/are rejected under 35 U.S.C. 103 as being unpatentable over Maier in view of Lee.

Claim 7 is/are rejected under 35 U.S.C. 103 as being unpatentable over Maier in view of Bidne.

Claim 8 is/are rejected under 35 U.S.C. 103 as being unpatentable over Maier in view of Lee and Jones

Claim 10 is/are rejected under 35 U.S.C. 103 as being unpatentable over Maier in view of Yang.

Claim 14-20 is/are rejected under 35 U.S.C. 103 as being unpatentable over Maier in view of Bidne and Jones.

Claim 1

Maier discloses **a method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:**



determining virtual morphometric measurements of the outer layer of the patient from the 3D data (e.g. creating a surface profile of CT data; Fig. 3; ¶ 113: “Initially, i.e. upon start of the visualization method, a graph-based registration process may be performed to obtain an initial alignment of the surface profile generated from the range image with a surface profile generated from the pre-recorded medical image data.”);

Medivis Exhibit 1004

patient 14 may be tracked and may be continuously updated to follow the movements of the display means 22 along the body of the patient 14”);

determining real-time morphometric measurements of the outer layer of the patient (e.g. creating a surface profile of patient from range data; Fig. 3; ¶ 113: “Initially, i.e. upon start of the visualization method, a graph-based registration process may be performed to obtain an initial alignment of the surface profile generated from the range image with a surface profile generated from the pre-recorded medical image data.”);

automatically registering a virtual position of the outer layer of the patient from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space using the virtual morphometric measurements and using the real-time morphometric measurements (Fig. 3 Registration of ToF surface and CT surface); **and**

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient (Maier, ¶ 29: “Said display means may comprise...a head-mounted display, or any 3D display”)

Claim 2

The cited prior art further discloses ~~the registering of the real-time position and the determining of the real-time morphometric measurements are accomplished using sensors included in the AR headset; and~~

~~the sensors include one or more of infrared sensors, sound sensors, photographic sensors, fluoroscopy sensors, accelerometers, gyroscopes, and~~

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magnetometers (Maier, ¶ 65: “A single sensor means, such as a single time-of-flight camera, may be sufficient to sense a distance from said sensor means to said surface of said subject, and to sense said object. Said sensor means may be a camera adapted to provide both a range image and a physical image, such as an intensity image.”).

The cited prior art does not disclose, but Lee makes obvious **the registering of the real-time position and the determining of the real-time morphometric measurements are accomplished using sensors included in the AR headset** (Lee, ¶ 75: “According to the illustrated embodiment, the augmented reality image display system 400 may include a camera 410 that captures a real image including a plurality of markers attached to the patient's body or a human body model, an augmented reality image generator 430 that detects the plurality of markers in the real image acquired by the camera 410, estimates position and gaze direction of the camera 410 using the detected markers, and generates an augmented reality image by overlaying a virtual image of a corresponding region over the real image, and a display 420 that displays the augmented reality image, as illustrated in FIG. 2”)

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Lee's teachings to integrate the sensor in a headset. The sensor performs the same function separately and in the integrated version. They could be combined to yield predictable results.

Claim 3

The cited prior art further discloses **the 3D data of the patient is captured in real-time; and the 3D data of the patient includes video** (Maier, ¶¶ 103-05: “The

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time-of-flight camera 26 is able to generate dense range images and corresponding grayscale intensity images from a given scene in real-time. Its operation principle is generally similar to that of a laser scanner, with the additional advantage that a whole scene may be captured at once. State of the art time-of-flight cameras provide more than 50 images per second...the visualization system 10 also comprises a conventional colour camera (not shown) to provide high resolution colour images of the scene...The visualization system 10 can be employed for on-patient visualization of pre-recorded medical images, such as the medical images provided by the computed tomography scanner 20, or any other medical imaging device suitable for acquiring static 3D images, such as a magnetic resonance imaging (MRI) scanner. Preferably, the medical imaging modality is chosen such that it provides surface information alongside information pertaining to the internal structures of the patient, e.g. a computer tomography scanner or a magnetic resonance imaging scanner. The medical image data may be acquired beforehand and may be recorded and stored, e.g. in the Picture Archiving and Communications System (PACS) of a hospital, from which they may be accessed by the visualization system 10.”)

Claim 4

The cited prior art further discloses **wherein the outer layer of the patient is a skin layer of the patient** (Maier, ¶ 38: “In this configuration, the image on display may contain both the visualization of (virtual) medical image data and a physical (real) image of the surface of a patient, such as the patient's skin or clothing.”).

Claim 5

The cited prior art further discloses **prior to the registering of the real-time position, positioning the patient in a different position as the patient was in when the 3D data of the patient was captured; and deforming the 3D data to match the different position of the patient** (e.g. change of surface characteristics from patient chest movement; Maier, ¶ 153: “registration compensate movement of the surface, such as may be caused by breathing, in order to provide a corrected indication of the relative position of the instrument with respect to the anatomical structure. This may compensate for the change of the needle trajectory relative to a patient's skin depending on the breathing state.”).

Claim 6

The cited prior art further discloses **wherein the 3D data includes one or more of MRI images, Computerized Tomography (CT) scan images, X-ray images, Positron Emission Tomography (PET) images, ultrasound images, fluorescence images, Infrared Thermography (IRT) images, and Single-Photon Emission Computed Tomography (SPECT) scan image** (Maier, ¶13: “this case, the anatomical data relating to said patient may be pre-recorded medical image data of said patient, for instance image data generated from raw data acquired during a CT scan or a MRI scan”).

Claim 7

The cited prior art does not explicitly disclose, but Bidne makes obvious **the projected inner layer of the 3D data of the patient is colored using a color gradient that represents tissue properties and that is altered to be visible when**

projected onto the real-time views of the outer layer of the patient (Bidne, ¶ 3: "Typical modern, digital imaging techniques include magnetic resonance imaging (MRI) and computed tomography (CT) scans. In addition to producing images that can be colored for more ready interpretation, such scans can also produce data files that can be automatically analyzed and manipulated in various manners"); **and**

the tissue properties include one or more of tissue hardness, relaxivity, echogenicity, enhancement amount, enhancement speed, density, radioactivity, and water content (Bidne, ¶ 9: "If contact is made, the system may note it, and perform both mechanical and material analysis on any around the points of contact. For example, for mechanical analysis, a system may cause deformation of tissue to occur in the model using finite element analysis techniques, and may also change a display of the model so as to show the tissue moving in response to the stress, and perhaps changing the displayed color of the tissue, where the new colors represent the level of stress or strain on the tissue at particular points. The system may also deform the device in response to computed forces from the tissue, and may display the deformed device graphically in an animation and/or generate and save, and display alphanumeric representations of parameters for the forces on the device and the tissue and the deformation of each").

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Bidne's teachings in order to color code tissue properties. Identification of tissue properties is well known and could be readily combined with color augmentation to identify specific characteristics to the reviewer.

Claim 8

Maier suggests (see ¶ 45) but does not explicitly disclose use of markers. Lee obvious **the method further comprises positioning ~~extra-visual~~ markers on the patient;**

the automatic registering further include automatically registering the real-time positions of the ~~extra-visual-markers~~ with respect to the registered real-time position of the outer layer of the patient in the 3D space (Lee, ¶ 80: "A plurality of markers M may be attached to the surface of the patient P lying on the operating table as illustrated in FIG. 4");

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Lee in order to use markers. The motivation would have been to track the position of the surface.

The cited prior art does not explicitly disclose, but Jones makes obvious **the method further comprises covering at least a portion of the patient and the extra-visual markers with an opaque surgical draping; the method further comprises sensing, using a sensor of the AR headset, the real-time positions of the extra-visual markers underneath the opaque surgical draping; and the method further comprises automatically re-registering a virtual position of the outer layer of the patient from the 3D data to align with the sensed real-time positions of the extra-visual markers** (Jones, ¶ 101: " The x-ray imagery data can include reference markers which can be created using small objects placed on the imaged object (e.g., patient's body) and which can be readily identified in the x-ray imagery")

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Jones to use extra-visual markers. The motivation would have been to maintain tracking despite occlusions. Surgical draping is not explicitly disclosed, but Jones's technique would be applicable.

Claim 9

The cited prior art further discloses **wherein the automatic registering is performed using point set registration** (Maier, ¶118: “Point-based registration: Based on the knowledge of the camera parameters, a surface profile may be generated from the range image and/or intensity image of the time-of-flight camera 26. A further surface profile may be extracted from the 3D medical data set. Both the surface profile generated from the time-of-flight camera 26 and the surface profile extracted from the 3D medical data set may be converted into point clouds”).

Claim 10

The cited prior art does not explicitly disclose, but Yang makes obvious **generating a confidence score that the automatic registering is correct; and presenting the confidence score to a user** (Yang, ¶ 157-58: “Intraoperatively registering the three-dimensional surface topology image data to additional image data of the structured segment may further include determining if registration is occurring within a pre-set confidence criteria... A prompt may be provided to a user, for example audibly, such as a beep, or visually, by text or flashing icon on a display 4.”)

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Yang's teachings to indicate confidence score. The motivation would have been to inform the user of the accuracy of the registration.

Claim 11

The same teachings and rationales in claim 1 are applicable to claim 11.

Claim 12

The same teachings and rationales in claim 1 are applicable to claim 12.

The cited prior art additionally discloses: **automatically tracking a real-time position of the object in the 3D space with respect to the registered real-time position of the outer layer of the patient in the 3D space and with respect to the registered virtual position of the outer layer of the patient from the 3D data; and while a portion of the object is inserted into the patient through the outer layer of the patient, displaying, in the AR headset, a virtual portion of the object projected into the projected inner layer of the patient from the 3D data** (Maier, ¶ 58: "The object may be an instrument such as a medical or surgical instrument, or any other kind of object that shall be placed at a predetermined position relative to said subject and/or shall be moved along a predetermined trajectory relative to said subject. Said position may be a position above or besides a surface of said subject, or may be a position in the interior of said subject. In the same way, said trajectory may be a trajectory extending above or besides the surface of said subject, or may extend partly in or through said subject. In particular, said trajectory may extend partly externally and partly internally with respect to said subject. For instance, said trajectory may be an insertion

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path such as a predetermined path along which a physician may want to insert a needle through the surface of the patient and to move the tip of said needle to a predetermined body part. The position of the surface relative to the anatomical structures may vary over time, such as if a patient breathes while being examined. The visualization means may be adapted to monitor, display and/or compensate this surface movement.”).

Claim 13

The same teachings and rationales in claim 12 are applicable to claim 13.

Claim 14

The same teachings and rationales in claim 1 are applicable to claim 14.

The cited prior art does not disclose, Bidne makes obvious **generating, in the AR headset, a virtual user interface that includes options for altering the display of the projected inner layer of the patient from the 3D data** (Fig. 1; ¶ 27: “along with a number of menu selections made available to the user 110. For example, one or more lines may be presented on the touch tablet 106, and a user may slide the lines across the touch tablet 106 by touching the end of a particular line and dragging in contact with the screen of the touch tablet 106. Such dragging may cause a line to intersect a 3D or 3D representation of the model, and may cause the computer system 104 to apply a cutting plane to the model so that the user 110 can see an interior portion of the model.”);

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Bidne's teachings in order to use a menu. The motivation would have been to allow the user to configure the display.

The cited combination does not explicitly disclose, but Jones makes obvious **displaying, in the AR headset, the virtual user interface projected onto real-time views while a focal orientation of the AR headset is not focused on the patient** (Jones, ¶ 71: "FIG. 11 illustrates operations triggered by when the surgeon's head tilts up above the first pitch threshold and below a second pitch threshold so the surgeon's line-of-sight is along line 704 through the display screen 752. The primary virtual display panel 710 disappears from the display screen 752 and the three video streams (e.g., HDMI channels B, C and D) become separately viewable or at least partially collectively viewable as the three secondary virtual display panels 720, 722, and 724 floating in space. These secondary virtual display panels 720, 722, and 724 may first appear at default radial positions on a sphere centered in the surgeon's head, but the surgeon can have the ability to reposition and resize them for maximum convenience."); **and**

hiding, in the AR headset, the virtual user interface while the focal orientation of the AR headset is focused on the patient (Fig. 10; ¶ 70: " In the example of FIG. 10, the surgeon's head is tilted downward below the first pitch threshold so that the surgeon's line-of-sight 702 is toward the operation site while looking through the TTL loupe. The surgeon may shift eye position upward so that the surgeon's line-of-sight 700 now looks through the display screen 752. The computer equipment 620 responds to the surgeon's head tilted below the first pitch threshold by operating in the

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full-screen operational mode to select a defined one of the video streams which it displays on the display screen 752 to generate the primary virtual display panel 710”).

As of the effective date of this application, it would have been obvious to one of ordinary skill in the art to combine Jones in order to respond to a focal orientation. The motivation would have been to allow hands free configuration.

Claim 15

The cited prior art further makes obvious **displaying, in the AR headset, a virtual cursor projected onto real-time views and/or onto the virtual user interface while a focal orientation of the AR headset is not focused on the patient; and hiding, in the AR headset, the virtual cursor while a focal orientation of the AR headset is focused on the patient** (use of a cursor is a well-known user interface technique (e.g. Jones, ¶ 74) and could be combined with Jones's focus based user interface. The benefit would have been use of pointing indicator and displaying the user interface when the user looks up)

Claim 16

The cited prior art further makes obvious **determining a real-time distance of the patient from the AR headset; and updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually positioned at a focal distance from the AR headset that is about equal to the real-time distance of the patient from the AR headset** (Jones, ¶ 67: “The example embodiments of FIGS. 10-12 allow a surgeon or other user to see several

Art Unit: 2611

virtual displays of different medical information without looking away from the surgical site and focusing far away to view physical monitors that may be mounted across the OR or elsewhere adjacent to the patient. In some embodiments, three operational "modes" of the virtual displays are selectively activated based upon pitch of the surgeon's head and the corresponding viewing line-of-sight of the user")

Claim 17

The cited prior art further discloses **updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually oriented perpendicularly to the focal orientation of the AR headset** (Jones, Figs. 10-12, video views follow direction of sight).

Claim 18

The cited prior art further makes obvious **displaying, in the AR headset, a virtual spatial difference box projected onto real-time views of the patient, the virtual spatial difference box confining within a volume of the virtual spatial difference box the projected inner layer of the patient from the 3D data** (Maier, ¶ 132: "In a slice view, the pose of the time-of-flight camera 26 may be used to reconstruct an image slice whose normal direction is given by the viewing direction of the time-of-flight camera 26, and whose depth is derived from the proximity of the camera 26 to the patient's surface")

Claim 19

The cited prior art further makes obvious **wherein the virtual spatial difference box is configured to selectively display two-dimensional (2D) slices and/or 3D**

slices of the projected inner layer of the patient from the 3D data (Maier, ¶ 132: “In a slice view, the pose of the time-of-flight camera 26 may be used to reconstruct an image slice whose normal direction is given by the viewing direction of the time-of-flight camera 26, and whose depth is derived from the proximity of the camera 26 to the patient's surface”).

Claim 20

The same teachings and rationales in claim 14 are applicable to claim 20.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to RYAN M. GRAY whose telephone number is (571)272-4582. The examiner can normally be reached on Monday through Friday, 9:00 am - 5:00 pm.

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, Kee Tung can be reached on (571) 272-7794. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2611

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.

/RYAN M GRAY/

Primary Examiner, Art Unit 2611

Notice of References Cited	Application/Control No. 15/474,702		Applicant(s)/Patent Under Reexamination CVETKO ET AL.	
	Examiner RYAN M. GRAY		Art Unit 2611	Page 1 of 1

U.S. PATENT DOCUMENTS

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CONFIRMATION NO. 9851

SERIAL NUMBER 15/474,702	FILING or 371(c) DATE 03/30/2017 RULE	CLASS 345	GROUP ART UNIT 2611	ATTORNEY DOCKET NO. N3039.10001US01	
APPLICANTS Novarad Corporation, American Fork, UT; INVENTORS Steven Cvetko, Draper, UT; Wendell Arlen Gibby, Mapleton, UT; ** CONTINUING DATA ***** ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED *** SMALL ENTITY ** 04/07/2017					
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and Acknowledged <u>/RYAN M. GRAY/</u> Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY UT	SHEETS DRAWINGS 11	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
ADDRESS Maschoff Brennan 1389 Center Drive, Suite 300 Park City, UT 84098 UNITED STATES					
TITLE AUGMENTING REAL-TIME VIEWS OF A PATIENT WITH THREE-DIMENSIONAL DATA					
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PTO/SB/08a (03-15)

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	Filing Date		2017-03-30
	First Named Inventor	Steven Cvetko, Ph.D.	
	Art Unit		
	Examiner Name	Not Yet Assigned	
	Attorney Docket Number	N3039.10001US01	

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Application Number		
Filing Date		2017-03-30
First Named Inventor	Steven Cvetko, Ph.D.	
Art Unit		
Examiner Name	Not Yet Assigned	
Attorney Docket Number	N3039.10001US01	

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	UNITED STATES PATENT APPLICATION NO. 15/438,715, titled "Augmented Reality Viewing And Tagging For Medical Purposes", filed February 21, 2017, 45 pages	

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EXAMINER SIGNATURE

Examiner Signature	/RYAN M GRAY/	Date Considered	05/15/2017
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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.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		2017-03-30
First Named Inventor	Steven Cvetko, Ph.D.	
Art Unit		
Examiner Name	Not Yet Assigned	
Attorney Docket Number	N3039.10001US01	

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	/John T. Gadd/ Reg. No. 52928	Date (YYYY-MM-DD)	2017-03-30
Name/Print	John T. Gadd	Registration Number	52928

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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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.
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Steven Cvetko	
Application No.:	15/474,702	Art Unit 3737
Filed:	March 30, 2017	
Conf. No.:	9851	
For:	AUGMENTING REAL-TIME VIEWS OF A PATIENT WITH THREE-DIMENSIONAL DATA	
Examiner:	Not Yet Assigned	
Customer No.:	97149	
Attorney Docket No.:	N3039.10001US01	

**RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS
OF NONPROVISIONAL APPLICATION**

Commissioner for Patents-
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Notice to file Corrected Application Papers mailed April 11, 2017, a Replacement Drawing in compliance with 37 CFR 18.4 and 37 CFR 1.121(d) is submitted with this communication.

The Replacement Sheet is submitted as 1/11. It is respectfully submitted that the Replacement Sheet does not add new matter to this application because the only change is to add the label "FIG. 1" at the bottom of the Replacement Sheet.

It is the Applicant's understanding that no additional fees are required. However if the Office identified any deficiency in the fee payment or determines that any other additional fees are required, the Commissioner is authorized to charge any such fees to Maschoff Brennan Deposit Account No.

Dated this 12th day of April, 2017.

Respectfully submitted,

/John T. Gadd/

JOHN T. GADD
Registration No. 52,928
Attorney for Applicants
Customer No. 97149
Telephone No. (435) 252-1360

AUGMENTING REAL-TIME VIEWS OF A PATIENT WITH THREE-DIMENSIONAL DATA

BACKGROUND

[0001] Augmented reality (AR) systems generally take a user's live view of a real-world environment and augment that view with computer-generated virtual elements such as video, sound, or graphics. As a result, AR systems function to enhance a user's current perception of reality.

[0002] One common problem faced by AR systems is accurately aligning the position of a virtual element with a live view of a real-world environment. This alignment process is often done manually or is done automatically only after manual placement of non-anatomical fiducials. In either case, the manual process can be time consuming, cumbersome, and inaccurate.

[0003] Another common problem faced by AR systems is proper placement of virtual controls for managing virtual elements. Virtual controls, while intended to aide a user in interacting with virtual elements, are often placed in positions in the live view that render them more of a hindrance than a help to the user.

[0004] The subject matter claimed herein is not limited to embodiments that solve any disadvantages or that operate only in environments such as those described above. Rather, this background is only provided to illustrate one example technology area where some embodiments described herein may be practiced.

SUMMARY

[0005] In one embodiment, a method for augmenting real-time views of a patient with three-dimensional (3D) data may include various acts. For example, the method may include identifying 3D data for a patient with the 3D data including an outer layer of the patient and multiple inner layers of the patient. The method may also include determining virtual morphometric

measurements of the outer layer of the patient from the 3D data. The method may further include registering a real-time position of the outer layer of the patient in a 3D space. The method may also include determining real-time morphometric measurements of the outer layer of the patient. The method may further include automatically registering the position of the outer layer of the patient from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space using the virtual morphometric measurements and using the real-time morphometric measurements. The method may also include displaying, in an augmented reality headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient.

[0006] In another embodiment, a method for augmenting real-time views of a patient with 3D data may include various acts. For example, the method may include identifying 3D data for a patient with the 3D data including an outer layer of the patient and multiple inner layers of the patient. The method may also include displaying, in an augmented reality headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient. The method may further include generating, in the augmented reality headset, a virtual user interface that includes options for altering the display of the projected inner layer of the patient from the 3D data. The method may also include displaying, in the augmented reality headset, the virtual user interface projected onto real-time views while a focal orientation of the augmented reality headset is not focused on the patient. The method may further include hiding, in the augmented reality headset, the virtual user interface while the focal orientation of the augmented reality headset is focused on the patient.

[0007] It is to be understood that both the foregoing summary and the following detailed description are explanatory and are not restrictive of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Embodiments will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

[0009] FIG. 1 illustrates an example augmented reality (AR) environment in which real-time views of a patient may be augmented with three-dimensional (3D) data;

[0010] FIGS. 2A-2F are photographs of the AR environment of FIG. 1 with a first patient;

[0011] FIG. 3 is a photograph of the AR environment of FIG. 1 with a second patient;

[0012] FIGS. 4A-4B are photographs of the AR environment of FIG. 1 with a third patient;

[0013] FIG. 5 illustrates an example computer system that may be employed in augmenting real-time views of a patient with 3D data; and

[0014] FIGS. 6A-6E are a flowchart of an example method of augmenting real-time views of a patient with 3D data.

DETAILED DESCRIPTION

[0015] Medical imaging may be employed to create visual representations of the interior of a patient. More particularly, medical imaging may be employed to reveal internal structures hidden by an outer layer of a patient, such as the skin, for various purposes such as training, research, diagnosis, and treatment.

[0016] Conventional medical imaging systems may create three-dimensional (3D) data for a patient and then display that 3D data as an image or images on a computer display. While viewing images of a patient on a computer display, detached from the actual patient, may be useful in training, research, diagnosis, and treatment, viewing, such detached viewing may also result in some problems.

[0017] For example, where a surgeon needs to remove a tumor from a patient's brain, the surgeon may view an image of the patient's brain on a computer display. After viewing the location of the tumor on the computer display, the surgeon may then shift his view from the computer display to the actual patient on an operating table and attempt to identify the approximate location on the actual patient of the tumor inside the patient's brain. This method of identifying the approximate location of the tumor can be difficult and error-prone. For example, the surgeon may accidentally identify the left side of the brain in the image as having the tumor when in reality the tumor is in the right side of the brain. This error may lead to the surgeon erroneously making an unnecessary incision on the left side of the patient's skull.

[0018] In another example, where a doctor needs to perform knee surgery on a patient, the doctor may view an image of the patient's knee on a computer display. After viewing the problematic area of the knee on the computer display, the doctor may then shift his view from the computer display to the actual patient on an operating table and attempt to identify the problematic area of the knee on the actual patient for the surgery. This method of identifying the problematic area of the knee can be difficult and error-prone. For example, the doctor may accidentally pull up images of the wrong patient on the computer display, without realizing that the patient on the operating table does not match the images on the computer display. This error may lead to the surgeon erroneously making an incision in the wrong location due to natural variation of problematic areas of the knee from one patient to the next.

[0019] The embodiments disclosed herein may provide various benefits over a conventional medical imaging system. In particular, the embodiments disclosed herein may, for example, augment real-time views of a patient with 3D data. In some embodiments, the 3D data of a patient may be automatically aligned, or registered, with a real-time view of the actual patient and then

images derived from the 3D data may be projected onto the real-time view of the patient. Thus, these embodiments may enable a medical professional to view a virtual interior of the patient while looking at the actual patient without any time consuming, cumbersome, and inaccurate manual alignment and/or without any time consuming, cumbersome, and inaccurate manual placement of non-anatomical fiducial. When used in training, research, diagnosis, or treatment, these embodiments may enable a medical professional to more easily and more accurately locate a target location within a patient.

[0020] For example, when employed in the brain surgery example discussed above, these embodiments may avoid the surgeon getting confused on the location of the tumor between the right and left sides of the brain, and may thereby avoid the surgeon making an unnecessary incision on the wrong side of the skull during the surgery to remove the tumor. Similarly, when employed in the knee surgery example discussed above, these embodiments may avoid the doctor using 3D data for the wrong patient because the automatic alignment may fail or may indicate a low confidence that the automatic alignment was correct, thus alerting the doctor that the patient data may not be for the patient currently on the operating table.

[0021] Further, in some embodiments, the augmenting of real-time views of a patient with 3D data may include the display of a virtual user interface and other virtual controls for altering the images projected onto the real-time view of the patient. This virtual user interface and these other virtual controls may be projected to avoid obstructing the medical professional's field of view when viewing the patient, to maintain a relatively constant focal length for the medical professional, and/or to maintain the orientation of the virtual user interface facing the medical professional. In this way, these embodiments may allow the medical professional to quickly and easily alter the images projected onto the real-time view of the patient.

[0022] Turning to the figures, FIG. 1 illustrates an example augmented reality (AR) environment 100. In some embodiments, the environment 100 may include a 3D space 102, a user 104, a patient 106, and an AR headset 108 which may be in communication with a server 112 over a network 110. In some embodiments, the environment 100 may also include a virtual user interface 114, a virtual spatial difference box 116, a virtual inserted portion 118a of an object 118, and a virtual cursor 122, all shown in dashed lines to indicate that these virtual elements are generated by the AR headset 108 and only viewable by the user 104 through the AR headset 108.

[0023] In some embodiments, the 3D space 102 may be any 3D space including, but not limited to, an operating room with an operating table 103 (as illustrated in FIG. 1), an office, a classroom, or a laboratory. In some embodiments, the 3D space 102 may be a space where the user 104 may view the patient 106 while wearing the AR headset 108.

[0024] In some embodiments, the user 104 may be any user of the AR headset 108 including, but not limited to, a medical professional (as illustrated in FIG. 1), an instructor, a researcher, a patient, or a caregiver of a patient. For example, a medical professional may use the AR headset 108 in order to perform a medical procedure on the patient 106. Similarly, a researcher or an instructor may use the AR headset 108 while performing medical research or instructing medical students. Further, a caregiver of the patient 106, or the patient 106 himself, may use the AR headset 108 when a medical professional is attempting to explain a suggested medical procedure for the patient 106.

[0025] In some embodiments, the patient 106 may be any animal, either conscious or unconscious, either living or dead, either whole or missing one or more body parts. For example, the patient 106 may be a living human adult (as illustrated in FIG. 1) who has been rendered unconscious in order to undergo a medical procedure by the user 104. In another example, the

patient 106 may be a cadaver of a human adult that will undergo a dissection for research or training purposes. In another example, the patient 106 may be a conscious animal that is being evaluated by a veterinarian in order to diagnose a medical condition. In another example, the patient 106 may be a single limb or organ of a deceased human.

[0026] In some embodiments, the AR headset 108 may be any computer system in the form of an AR headset that is capable of augmenting real-time views of the patient 106 with 3D data. For example, the AR headset 108 may be employed by the user 104 in order to augment a real-time view of the patient 106 with one or more inner layers of the patient 106 including, but not limited to, bones 106b (as illustrated in FIG. 1), muscles, organs, or fluids. In some embodiments, the AR headset 108 may perform this augmenting of a real-time view of the patient 106 regardless of the current position of the user 104 in the 3D space 102. For example, the user 104 may walk around the operating table 103 and view the patient 106 from any angle within the 3D space 102, and all the while the AR headset 108 may continually augment the real-time view of the patient 106 with one or more inner layers of the patient 106, so that both the patient 106 and the 3D data of the patient 106 may be viewed by the user 104 from any angle within the 3D space 102. The AR headset 108 may perform this augmenting of a real-time view of the patient 106 with 3D data according to the method 600 disclosed herein in connection with FIGS. 6A-6E. In some embodiments, the AR headset 108 may be a modified version of the Microsoft HoloLens.

[0027] In some embodiments, the network 110 may be configured to communicatively couple the AR headset 108 and the server 112 or other computer system(s). In some embodiments, the network 110 may be any wired or wireless network, or combination of multiple networks, configured to send and receive communications between systems and devices. In some embodiments, the network 110 may include a Personal Area Network (PAN) such as a Bluetooth

network, a Local Area Network (LAN) such as a WiFi network, a Metropolitan Area Network (MAN), a Wide Area Network (WAN), or a Storage Area Network (SAN). In some embodiments, the network 110 may also be coupled to, or may include, portions of a telecommunications network for sending data in a variety of different communication protocols, such as a cellular network.

[0028] In some embodiments, the server 112 may be any computer system capable of functioning in connection with the AR headset 108. In some embodiments, the server 112 may be configured to communicate in real-time with the AR headset 108 in order to convey 3D data to, or receive data from, the AR headset 108. In addition, the server 112 may be employed to offload some or all of the data storage or processing desired by the AR headset 108.

[0029] In some embodiments, the virtual user interface 114 may be any virtual user interface generated by the AR headset 108 that includes options for altering the display of the projected inner layer(s) of the patient 106 from the 3D data of the patient 106. For example, the options included in the virtual user interface 114 may include, but are not limited to, options that cause the AR headset 108 to:

- (1) quit viewing the augmented view of the patient 106,
- (2) display a demo of the capabilities of the AR headset 108,
- (3) adjust the characteristics of the 3D data that is projected onto the patient 106, such as the brightness and color of the projected 3D data,
- (4) adjust the alignment of the 3D data with the patient 106,
- (5) display the virtual spatial difference box 116,
- (6) display a slice of the 3D data instead of a volume of the 3D data,
- (7) drag the 3D data in a direction of the user 104, such as in the repositioning of a slice of the 3D data,

(8) display different slices of the 3D data including, but not limited to, axial slices, coronal slices, sagittal slices, and oblique slices, and

(9) perform other advanced features of the AR headset 108.

The virtual user interface 114 may further include other information that may be useful to the user 104. For example, the virtual user interface 114 may include real-time vital signs for the patient 106 such as heart-rate, blood-pressure, and respiration-rate. In another example, the virtual user interface 114 may include a stopwatch showing the amount of time the patient 106 has been unconscious.

[0030] In some embodiments, the AR headset 108 may be configured to display the virtual user interface 114 at a comfortable distance from the user 104 and/or in a comfortable orientation for the user 104. For example, the AR headset 108 may be configured to display the virtual user interface 114 at a focal distance D2 from the AR headset 108 that is about equal to a real-time distance D1 of the patient 106 from the AR headset 108. This distance may be comfortable for the user because it may avoid the user 104 from having to refocus his eyes when shifting his focus between the patient 106 and the virtual user interface 114, even as the user moves around the 3D space 102 and even as the user moves closer to and further away from the patient 106. In another example, the AR headset 108 may be configured to display the virtual user interface 114 at a focal orientation that is oriented perpendicularly to a focal orientation 120 of the AR headset 108. This orientation may be comfortable for the user 104 because it may cause the virtual user interface 114 to constantly face the user 104 head-on regardless of the current focal orientation 120 of the AR headset 108, even as the user moves around the 3D space 102 and even as the user generally faces toward or faces away from the patient 106.

[0031] In some embodiments, the virtual spatial difference box 116 may be generated by the AR headset 108 to confine within a volume of the virtual spatial difference box 116 the projected inner layer of the patient 106 from the 3D data. For example, the projected bones 106b of the patient 106 may be confined within the virtual spatial difference box 116 in FIG. 1. In some embodiments, the virtual spatial difference box 116 may also assist the user when navigating the projected 3D data by providing a frame of reference for the user 104. For example, this frame of reference may assist the user when moving axial slices, coronal slices, sagittal slices, or oblique slices of the 3D data within the virtual spatial difference box 116. Slices may be two-dimensional (2D) slices and/or 3D slices. 3D slices may include curved slices, such as curved slices that follow the natural curve of an anatomical feature, or slices that have a depth as well as a height and width. The user 104 may move these slices using hand gestures that require the user 104 to generally move his hand in the directions of the lines of the virtual spatial difference box 116, so the display of the virtual spatial difference box 116 may make these hand movements easier for the user 104.

[0032] In some embodiments, the virtual inserted portion 118a of the object 118 may correspond to any portion of the object 118 that the user 104 wishes to insert into the patient 106 through an outer layer of the patient 106. For example, the object 118 may include, but is not limited to, a scalpel (as illustrated in FIG. 1), a scope, a drill, a probe, another medical instrument, or even the hand of the user 104. Similar to the registration of the real-time position of the outer layer of the patient 106, the position of the outer layer of the object 118 may also be registered. However, unlike the patient 106, which may remain relatively still in the environment 100, the object 118 may be frequently moved in the environment 100, such that the real-time position of the object 118 may be automatically tracked in the 3D space 102 with respect to the registered positions of the outer layer of the patient 106. Then, in the event that the user 104 inserts some portion of the

object 118 into the outer layer of the patient 106, the AR headset 108 may display a virtual inserted portion 118a of the object 118 projected into the projected inner layer of the patient 106 from the 3D data. In this manner, the virtual inserted portion 118a of the object 118 may be projected onto the real-time view of the user 104 even when the actual inserted portion of the object 118 is hidden from the real-time view of the user 104.

[0033] In some embodiments, the object 118 may be specifically designed to enable more accurate tracking of the object 118 by the AR headset 108. For example, where the object 118 is a relatively small medical instrument, such as a syringe with a needle, the object 118 may be enhanced to be more easily sensed by sensors of the AR headset 108. For example, these medical instruments may be sized larger to be more easily sensed (by a visual sensor for example), may be given a specific shape to be more easily sensed (such as by shaping the tip of the syringe to which the needle attaches as a sphere), may be made more visible to be more easily sensed (such as by adding a reflective strip or a light strip), or may be made from a material that is more easily sensed (such as by being made from metal to be more easily sensed by a metal detector sensor).

[0034] Further, in some embodiments, an attachment may be added to the object 118, such as to a handle of the object 118, to enable more accurate tracking of the object 118 by the AR headset 108. For example, the attachment may include any of the enhancements noted above to make the attachment more easily sensed by sensors of the AR headset 108 and, by virtue of the attachment being attached to the object 118, thereby also making the object 118 more easily sensed by sensors of the AR headset 108. Further, the attachment may be designed to attach to the portion of the object 118 that is intended to be inserted into the patient 106, such as the tip of the object 118, so that sensors of the AR headset 108 can actually sense the attachment inside the patient 106. For example, a small magnetic-field-emitting attachment may be attached to a tip of the object 118,

and a magnetic sensor of the AR headset 108 may then be able to sense the exact location of the attachment within the patient 106, thereby helping to improve the accuracy of the virtual inserted portion 118a displayed to the user 104.

[0035] In some embodiments, the virtual cursor 122 may be a virtual cursor generated by the AR headset 108 on the virtual user interface 114, on another virtual control, or at any other position in the 3D space 102. In some embodiments, the position of the virtual cursor 122 may correspond to the focal orientation 120 of the AR headset 108, which may correspond to the orientation of the head of the user 104. The virtual cursor 122 may be employed by the user 104 to select one or more options of the virtual user interface 114, sometimes in connection with one or more other actions by the user 104, such as a blink of the user's eyes, or one or more hand gestures of the user 104, such as the tapping together of two fingers in the field of view of the AR headset 108.

[0036] Modifications, additions, or omissions may be made to the environment 100 without departing from the scope of the present disclosure. For example, in some embodiments, multiple users each wearing an AR headset 108 may be simultaneously present in the 3D space 102 in order to simultaneously view the patient 106 augmented with 3D data of the patient 106. In another example, multiple patients may be simultaneously present in the 3D space 102 in order to allow the user 104 wearing the AR headset 108 to simultaneously view the multiple patients augmented with 3D data of the patients. In another example, multiple users each wearing an AR headset 108 and multiple patients may simultaneously be present in the 3D space. In another example, video of the view from the AR headset 108 may be captured by the AR headset 108 and then sent to a remote location, such as to the server 112 over the network 110 or to a remote AR headset or Virtual Reality (VR) headset for viewing by another user. This example may enable the remote user to guide the local user 104 through a medical procedure on the patient 106. Further, although

the environment 100 is generally disclosed to be in the context of a user 104 viewing a patient 106, it is understood that the environment 100 may be more broadly defined as any environment where a user wishes to view one or more inner layers of any object, such as a tree, a rock, an oilfield, or a planet.

[0037] In another example, the AR headset 108 may additionally or alternatively be controlled by the user 104 using voice commands. For example, the user 104 may employ voice commands because his hands are occupied with surgery or other medical treatment on the patient 106, and therefore controlling the AR headset 108 headset using hand gestures is not convenient. In this example, the voice commands may be employed to control the virtual user interface 114 (e.g., to select an option on the virtual user interface 114), the virtual spatial difference box 116 (e.g., to toggle between displaying and hiding the virtual spatial difference box 116 or to reposition slices of 3D data displayed in the virtual spatial difference box 116), or the virtual cursor 122 (e.g., to toggle between displaying and hiding the virtual cursor 122 projected onto the patient 106), or some combination thereof. Further, in this example, the voice commands may be employed separately from any other virtual controls. For example, voice commands may be employed to toggle between displaying and hiding, or to adjust the level of transparency of, the 3D data projected onto the patient 106, which may be useful while the user 104 is performing surgery on the patient 106 and may allow the user 104 to only view the projected 3D data when it is needed and to avoid viewing the projected 3D data, or make the 3D data more transparent, when the 3D data becomes a distraction. In another example, controls of the AR headset 108, such as the virtual user interface 114, may present options to the user 104, at least in part, audibly. The audible presentation of options may allow the user 104 to first hear voice options (e.g., potential voice commands) before actually speaking voice commands. The audible presentation of options may

also allow the user 104 to maintain the focal orientation 120 of the AR headset 108, and/or the visual focus of the user 104, on the patient 106 while still being able to interact with a virtual control that is not currently in his field of vision and/or that is currently hidden by the AR headset 108.

[0038] FIGS. 2A-2F are photographs of the AR environment 100 of FIG. 1 with a first patient. As disclosed in FIG. 2A, a user may wear an AR headset that augments a real-time view of the first patient with 3D data of the first patient. Also disclosed in FIG. 2A, the user may employ hand gestures in order to manipulate virtual controls of the AR headset. FIGS. 2B-2F disclose actual views from the perspective of the user wearing an AR headset. As disclosed in FIG. 2B, a user may employ a hand gesture in order to have an axial slice of 3D data representing a CT image of the patient's brain projected onto a real-time view of the first patient. As disclosed in FIG. 2C, a virtual spatial difference box may be employed by the user to view the same axial slice of the 3D data representing the CT image of the first patient's brain. As disclosed in FIG. 2D, as the user wearing the AR headset walks counter-clockwise around the first patient, the same axial slice of the 3D data representing the CT image of the first patient's brain may be viewed from different angles in the 3D space. As disclosed in FIGS. 2E and 2F, the user may manipulate one or more options of a virtual user interface to change from viewing the axial slice to a sagittal slice, and then from the sagittal slice to a coronal slice, respectively.

[0039] FIG. 3 is a photograph of the AR environment of FIG. 1 in use with a second patient. In particular, FIG. 3 discloses an actual view from the perspective of the user wearing an AR headset. As disclosed in FIG. 3, the AR headset may update, in real-time, the displaying of a virtual user interface to cause the virtual user interface to be continually positioned at a focal distance from the AR headset that is about equal to the real-time distance of the second patient from the

AR headset. Further, the AR headset may update, in real-time, the displaying of the virtual user interface to cause the virtual user interface to continually be oriented perpendicularly to the focal orientation of the AR headset.

[0040] FIGS. 4A-4B are photographs of the AR environment of FIG. 1 with a third patient. In particular, FIGS. 4A-4B disclose an actual view from the perspective of the user wearing an AR headset. As disclosed in a comparison of FIGS. 4A and 4B, the AR headset may be configured to display the virtual user interface projected onto a real-time view (as disclosed in FIG. 4B) while a focal orientation of the AR headset is not focused on the third patient, but then hide the virtual user interface while the focal orientation of the AR headset is focused on the third patient. In this manner, the AR headset may avoid the virtual user interface from obstructing the view of the third patient. In some embodiments, and since the third patient is generally positioned below a horizontal view, the AR headset may avoid the virtual user interface from obstructing the view of the third patient by displaying the virtual user interface when the focal orientation of the AR headset is above horizontal and by hiding the virtual user interface when the focal orientation of the AR headset is at or below horizontal. In these embodiments, the user can view the virtual user interface by simply looking up at any time while wearing the AR headset.

[0041] As disclosed in the photographs of FIGS. 2A-4B, the projected inner layers of the 3D data of the three patients may be colored using color gradients that represent tissue properties and that are altered, from standard color gradients, to be visible when projected onto the real-time views of the outer layer of the three patients. For example, in some embodiments where the 3D data includes one or more of CT scan images and X-ray images, the tissue properties represented by the color gradient may include tissue hardness ranging from softest tissue to hardest tissue. In other embodiment, the tissue properties represented by the color gradient may include, but are not

limited to, one or more of relaxivity, echogenicity, enhancement amount, enhancement speed, density, radioactivity, and water content. In order for the color gradient to be easily visible by the user wearing the AR headset, the color gradient may be altered to be lighter in color than standard color gradients used on computer displays since darker color gradients may blend into the view of the patient when projected onto the patient.

[0042] FIG. 5 illustrates an example computer system 500 that may be employed in augmenting views of a patient with 3D data. In some embodiments, the computer system 500 may be part of any of the systems or devices described in this disclosure. For example, the computer system 500 may be part of any of the AR headset 108 or the server 112 of FIG. 1.

[0043] The computer system 500 may include a processor 502, a memory 504, a file system 506, a communication unit 508, an operating system 510, a user interface 512, and an AR module 514, which all may be communicatively coupled. In some embodiments, the computer system 500 may be, for example, a desktop computer, a client computer, a server computer, a mobile phone, a laptop computer, a smartphone, a smartwatch, a tablet computer, a portable music player, an embedded computer, an AR headset, a VR headset, or any other computer system.

[0044] Generally, the processor 502 may include any suitable special-purpose or general-purpose computer, computing entity, or processing device including various computer hardware or software modules and may be configured to execute instructions stored on any applicable computer-readable storage media. For example, the processor 502 may include a microprocessor, a microcontroller, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a Field-Programmable Gate Array (FPGA), or any other digital or analog circuitry configured to interpret and/or to execute program instructions and/or to process data, or any combination thereof. In some embodiments, the processor 502 may interpret and/or execute

program instructions and/or process data stored in the memory 504 and/or the file system 506. In some embodiments, the processor 502 may fetch program instructions from the file system 506 and load the program instructions into the memory 504. After the program instructions are loaded into the memory 504, the processor 502 may execute the program instructions. In some embodiments, the instructions may include the processor 502 performing one or more blocks of the method 600 of FIGS. 6A-6E.

[0045] The memory 504 and the file system 506 may include computer-readable storage media for carrying or having stored thereon computer-executable instructions or data structures. Such computer-readable storage media may be any available non-transitory media that may be accessed by a general-purpose or special-purpose computer, such as the processor 502. By way of example, and not limitation, such computer-readable storage media may include non-transitory computer-readable storage media including Read-Only Memory (ROM), Electrically Erasable Programmable Read-Only Memory (EEPROM), Compact Disc Read-Only Memory (CD-ROM) or other optical disk storage, magnetic disk storage or other magnetic storage devices, flash memory devices (e.g., solid state memory devices), or any other storage media which may be used to carry or store desired program code in the form of computer-executable instructions or data structures and which may be accessed by a general-purpose or special-purpose computer. Combinations of the above may also be included within the scope of computer-readable storage media. Computer-executable instructions may include, for example, instructions and data configured to cause the processor 502 to perform a certain operation or group of operations, such as one or more blocks of the method 600 of FIGS. 6A-6E. These computer-executable instructions may be included, for example, in the operating system 510, in one or more applications, such as the AR module 514, or in some combination thereof.

[0046] The communication unit 508 may include any component, device, system, or combination thereof configured to transmit or receive information over a network, such as the network 110 of FIG. 1. In some embodiments, the communication unit 508 may communicate with other devices at other locations, the same location, or even other components within the same system. For example, the communication unit 508 may include a modem, a network card (wireless or wired), an infrared communication device, a wireless communication device (such as an antenna), and/or chipset (such as a Bluetooth device, an 802.6 device (e.g., Metropolitan Area Network (MAN)), a WiFi device, a WiMax device, a cellular communication device, etc.), and/or the like. The communication unit 508 may permit data to be exchanged with a network and/or any other devices or systems, such as those described in the present disclosure.

[0047] The operating system 510 may be configured to manage hardware and software resources of the computer system 500 and may be configured to provide common services for the computer system 500.

[0048] The user interface 512 may include any device configured to allow a user to interface with the computer system 500. For example, the user interface 512 may include a display, such as an LCD, LED, or other display, such as an AR lens, that is configured to present video, text, application user interfaces, and other data as directed by the processor 502. The user interface 512 may further include a mouse, a track pad, a keyboard, a touchscreen, volume controls, other buttons, a speaker, a microphone, a camera, any peripheral device, or other input or output device. The user interface 512 may receive input from a user and provide the input to the processor 502. Similarly, the user interface 512 may present output to a user.

[0049] The AR module 514 may be one or more computer-readable instructions stored on one or more non-transitory computer-readable media, such as the memory 504 or the file system 506,

that, when executed by the processor 502, is configured to perform one or more methods, such as one or more of the blocks of the method 600 of FIGS. 6A-6E. In some embodiments, the AR module 514 may be part of the operating system 510 or may be part of an application of the computer system 500, or may be some combination thereof.

[0050] Modifications, additions, or omissions may be made to the computer system 500 without departing from the scope of the present disclosure. For example, although each is illustrated as a single component in FIG. 5, any of the components 502-514 of the computer system 500 may include multiple similar components that function collectively and are communicatively coupled. Further, although illustrated as a single computer system, it is understood that the computer system 500 may include multiple physical or virtual computer systems that are networked together, such as in a cloud computing environment, a multitenancy environment, or a virtualization environment.

[0051] FIGS. 6A-6E are a flowchart of an example method 600 for augmenting views of a patient with 3D data. The method 600 may be performed, in some embodiments, by a device or system, such as by the AR module 514 of FIG. 5 executing on the AR headset 108 and/or on the server 112 of FIG. 1. In these and other embodiments, the method 600 may be performed by one or more processors based on one or more computer-readable instructions stored on one or more non-transitory computer-readable media. The method 600 will now be described in connection with FIGS. 1, 2A-2F, 3, 4A-4B, 5, and 6A-6E. Although the method 600 is described below as being performed by an AR headset, it is understood that the method 600 may alternatively be performed by another computer system or combination of computer systems.

[0052] At block 602, an AR headset may identify 3D data for a patient. For example, the AR headset 108 of FIG. 1 may identify, at block 602, 3D data for the patient 106.

[0053] In some embodiments, 3D data for the patient 106 of FIG. 1 may be captured or generated using one or more methods, either in real-time while the patient 106 is in the environment 100 and/or prior to the patient 106 entering the environment 100. For example, some of the 3D data may be obtained prior to the patient 106 entering the environment 100, and then the 3D data may be augmented with additional 3D data that is obtained in real-time while the patient 106 is in the environment 100. For example, 3D data of the patient 106 may include, but is not limited to, MRI images, Computerized Tomography (CT) scan images, X-ray images, Positron Emission Tomography (PET) images, ultrasound images, fluorescence images, Infrared Thermography (IRT) images, or Single-Photon Emission Computed Tomography (SPECT) scan image, or some combination thereof. Any of these images may be in the form of still images or video images. For example, the method 600 may employ still X-ray images of the skeletal system of the patient 106 (as illustrated in FIG. 1). In another example, the method 600 may employ video images of an ultrasound of a beating heart of the patient 106. In another example, the method 600 may be capable of toggling between a still image of the heart and a real-time video of the heart beating.

[0054] Although obtained using a variety of different methods, 3D data for a patient may, in some embodiments, include an outer layer of the patient and multiple inner layers of the patient. For example, the outer layer of the patient 106 of FIG. 1 may include the skin 106a of the patient 106 and/or the clothing 107 worn by the patient 106 in FIG. 1. In another example, the outer layer of a cadaver may be a tissue layer other than skin, such as a layer of muscle or fat, where the skin has been removed from the cadaver. The inner layers of the patient 106 may include, but are not limited to, interior bones 106b (as illustrated in FIG. 1), muscles, organs, or fluids of the patient 106. 3D data may include a 2D image, such as an X-ray image, because when the 2D image is

projected into a 3D space the 2D image has 3D significance. For example, 3D data for the patient 106 may include a 2D X-ray image that may be projected onto the skin 106a or the clothing 107 of the patient 106. 3D data may also include a time element, which is sometimes referred to as four-dimensional (4D) data. For example, 3D data may include video that includes not only 3D images, but also include 3D images changing over time. The multiple inner layers may be layers that go all the way through the patient 106, or may be layers that only go to a certain partial depth into the patient 106. For example, some forms of 3D data, such as 3D data derived from a millimeter wave scanner, may only be configured to reveal items stored between the outer clothing and the skin of a patient. The 3D data may additionally or alternatively be data that only generally corresponds to the patient 106, instead of specifically corresponding to the patient 106, such as 3D data derived from a preset anatomy atlas. The 3D data may also be a combination of various types of 3D data.

[0055] In some embodiments, care may be taken to position the patient 106 of FIG. 1 on the operating table 103 in the same relative position and/or orientation that the patient 106 was in when the 3D data was captured. Alternatively, when the patient 106 is positioned in a different position and/or orientation on the operating table 103 than the patient 106 was in when the 3D data was captured or generated, the AR headset 108 may deform the 3D data to match the different position and/or orientation of the patient 106.

[0056] At block 604, an AR headset may determine virtual morphometric measurements of the outer layer of the patient from the 3D data. For example, the AR headset 108 of FIG. 1 may determine, at block 604, virtual morphometric measurements of the outer layer of the patient 106 from the 3D data. The determining of these virtual morphometric measurements may involve the AR headset 108 analyzing the 3D data in order to determine the size and shape of the outer layer

of the patient from the 3D data. In some embodiments, the virtual morphometric measurements of the outer layer may involve generating a point cloud of the outer layer that represents the size and shape of the outer layer. For example, where the outer layer is represented by triangles or other polygonal shapes, the point cloud may include some or all of the vertices of the polygonal shapes.

[0057] At block 606, an AR headset may register a real-time position of the outer layer of the patient in a 3D space. For example, the AR headset 108 of FIG. 1 may register, at block 606, a real-time position of the skin 106a and clothing 107 of the patient 106 in the 3D space 102. In some embodiments, the AR headset 108 may include one or more sensors that are configured to map the 3D space 102, and map the real-time position of the outer layer of the patient 106 within the 3D space 102. These sensors may include, but are not limited to, infrared sensors, sound sensors, photographic sensors, fluoroscopy sensors, accelerometers, gyroscopes, or magnetometers.

[0058] At block 608, an AR headset may determine real-time morphometric measurements of the outer layer of the patient. For example, the AR headset 108 of FIG. 1 may determine, at block 608, real-time morphometric measurements of the skin 106a and clothing 107 of the patient 106. In some embodiments, the sensors employed in the registration at block 606 may also be employed to determine the real-time size and shape of the skin 106a and clothing 107 of the patient 106. In some embodiments, this may involve generating a point cloud of the skin 106a and clothing 107 of the patient 106 that represents the size and shape of the skin 106a and clothing 107.

[0059] At block 610, an AR headset may automatically register the position of the outer layer of the patient from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space. For example, the AR headset 108 of FIG. 1 may automatically register, at block 610, the position of the outer layer of the patient 106 from the 3D data to align with the

registered real-time position of the skin 106a and clothing 107 of the patient 106 in the 3D space 102. In some embodiments, this automatic registration may include automatically aligning the point cloud generated at block 604 with the point cloud generated at block 608 using point set registration. The automatic registration at block 610 may be less time consuming, less cumbersome, and less error-prone than manual methods of aligning an outer layer of a patient from 3D data with a real-time outer layer of the patient. Further, in some embodiments, the block 610 may be performed without using any non-anatomical fiducial, which may avoid the time consuming, cumbersome, and inaccurate placement of non-anatomical fiducials.

[0060] At block 612, an AR headset may display one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient. For example, the AR headset 108 of FIG. 1 may display, at block 612, the bones 106b of the patient 106 from the 3D data projected onto real-time views of the skin 106a and clothing 107 of the patient 106. In another example, a CT scan image of the brain of the patient is projected onto the top of the head of the patient in FIGS. 2B and 2C, or onto the side of the head of the patient in FIG. 2E.

[0061] At block 614, an AR headset may generate a confidence score that the automatic registration is correct and, at block 616, an AR headset may present the confidence score to a user. For example, the AR headset 108 of FIG. 1 may generate, at block 614, a confidence score that the automatic registration that was performed at block 612 is correct and present the confidence score to the user 104 visually, audibly, or in some other presentation format. In some embodiments, the AR headset 108 may generate this confidence score as part of the point set registration performed at block 612. For example, the confidence score may be a score between 0% and 100% indicating the level of confidence that the outer layer of the 3D data matches the outer layer of the patient 106. Where the confidence score is relatively high, the user 104 may proceed with training,

research, diagnosis, or treatment on the patient 106 using the AR headset 108 with confidence that the 3D data being projected onto the patient 106 does, in reality, correspond to the patient 106. On the other hand, where the confidence score is relatively low, the user 104 may halt any training, research, diagnosis, or treatment on the patient 106 using the AR headset 108 because there may be legitimate doubts as to whether the 3D data being projected onto the patient 106 does, in reality, correspond to the patient 106.

[0062] At block 618, an AR headset may determine real-time morphometric measurements of an object prior to insertion of the object into the patient through the outer layer of the patient. For example, the AR headset 108 of FIG. 1 may determine, at block 618, real-time morphometric measurements of the object 118 prior to insertion of the object 118 into the patient 106 through the outer layer of the patient 106. In some embodiments, the determination at block 618 may be performed in a manner similar to the determination at block 608. In other embodiments, especially for a standard object, such as a standard medical instrument, the determination at block 618 may be performed by accessing morphometric measurements of the standard object found in design documents for the standard object.

[0063] At block 622, an AR headset may track a real-time position of the object in the 3D space with respect to the registered positions of the outer layer of the patient in the 3D space and with respect to the registered position of the outer layer of the patient from the 3D data. For example, the AR headset 108 of FIG. 1 may automatically track, at block 622, the real-time position of the object 118 in the 3D space 102 with respect to the registered position of the skin 106a and the clothing 107 of the patient 106 in the 3D space 102 and with respect to the registered position of the outer layer of the patient 106 from the 3D data.

[0064] At block 624, while a portion of the object is inserted into the patient through the outer layer of the patient, an AR headset may display a virtual portion of the object projected into the projected inner layer of the patient from the 3D data. For example, while a portion of the object 118 of FIG. 1 is inserted into the patient 106 through the clothing 107 of the patient 106, the AR headset 108 may display a virtual inserted portion 118b of the object 118 projected into the projected bones 106b of the patient 106 from the 3D data.

[0065] At block 626, an AR headset may display a virtual spatial difference box projected onto real-time views of the patient. For example, the AR headset 108 of FIG. 1 may display, at block 626, the virtual spatial difference box 116 projected onto real-time views of the patient 106. In some embodiments, the virtual spatial difference box 116 may confine within a volume of the virtual spatial difference box 116 the projected inner layer of the patient 106 from the 3D data, such as the projected bones 106b of FIG. 1.

[0066] At block 628, an AR headset may generate a virtual user interface that includes options for altering the display of the projected inner layer of the patient from the 3D data. For example, the AR headset 108 of FIG. 1 may generate, at block 628, the virtual user interface 114 that includes options for altering the display of the projected bones 106b of the patient 106 from the 3D data.

[0067] At block 630, an AR headset may display the virtual user interface projected onto real-time views while a focal orientation of the AR headset is not focused on the patient. For example, the AR headset 108 of FIG. 1 may display, at block 630, the virtual user interface 114 projected onto real-time views while the focal orientation 120 of the AR headset 108 is not focused on the patient 106.

[0068] At block 632, an AR headset may hide the virtual user interface while the focal orientation of the AR headset is focused on the patient. For example, the AR headset 108 of FIG. 1 may hide, at block 632, the virtual user interface 114 while the focal orientation 120 of the AR headset 108 is focused on the patient 106. In some embodiments, blocks 630 and 632 may avoid the virtual user interface 114 from obstructing any view of the patient 106.

[0069] At block 634, an AR headset may determine a real-time distance of the patient from the AR headset. For example, the AR headset 108 of FIG. 1 may determine, at block 634, the real-time distance D1 of the patient 106 from the AR headset 108. This real-time distance D1 may be, for example, the real-time distance to the center of the patient 106, to the center of an area of focus of the patient 106, to a slice of the 3D data currently being viewed on the patient 106, or some other point or general area on the patient 106.

[0070] At block 636, an AR headset may update, in real-time, the display of the virtual user interface to cause the virtual user interface to be continually positioned at a focal distance from the AR headset that is about equal to the real-time distance of the patient from the AR headset. For example, the AR headset 108 of FIG. 1 may update, in real-time, at block 636, the display of the virtual user interface 114 to cause the virtual user interface 114 to be continually positioned at a focal distance D2 from the AR headset 108 that is about equal to the real-time distance D1 of the patient 106 from the AR headset 108. This focal distance D2 may be comfortable for the user 104 because it may avoid the user 104 having to change the focus of his eyes when shifting his focus between the patient 106 and the virtual user interface 114.

[0071] At block 638, an AR headset may update, in real-time, the display of the virtual user interface to cause the virtual user interface to continually be oriented perpendicularly to the focal orientation of the AR headset. For example, the AR headset 108 of FIG. 1 may update, in real-

time, at block 638, the display of the virtual user interface 114 to cause the virtual user interface 114 to continually be oriented perpendicularly to the focal orientation 120 of the AR headset 108. Where the virtual user interface 114 is positioned above the AR headset 108, as disclosed in FIG. 1, orienting the virtual user interface 114 perpendicularly to the AR headset 108 may cause the top of the virtual user interface 114 to be tilted slightly downward toward the AR headset 108, as disclosed in FIG. 1. This orientation may be comfortable for the user 104 because it may cause the virtual user interface 114 to constantly face the user 104 head-on regardless of the current focal orientation 120 of the AR headset 108 and regardless of where the user 104 is standing in the 3D space 102.

[0072] At block 640, an AR headset may display a virtual cursor projected onto real-time views and/or onto the virtual user interface while a focal orientation of the AR headset is not focused on the patient. For example, the AR headset 108 of FIG. 1 may display, at block 640, the virtual cursor 122 projected onto real-time views and/or onto the virtual user interface 114 while the focal orientation 120 of the AR headset 108 is not focused on the patient 106.

[0073] At block 642, an AR headset may hide the virtual cursor while a focal orientation of the AR headset is focused on the patient. For example, the AR headset 108 of FIG. 1 may hide, at block 642, the virtual cursor 122 while the focal orientation 120 of the AR headset 108 is focused on the patient 106. In some embodiments, blocks 640 and 642 may avoid the virtual cursor 122 from obstructing any view of the patient 106. In some embodiment, the AR headset 108 of FIG. 1 may only selectively hide, at block 642, the virtual cursor 122 while the focal orientation 120 of the AR headset 108 is focused on the patient 106. In these embodiments, there may be situations where the user 104 may desire to use the virtual cursor 122 while the focal orientation 120 of the AR headset 108 is focused on the patient 106, such as when the user 104 is using an annotation

tool to annotate the view of the patient 106 and/or to annotate the projected 3D data (e.g., a cross-hairs annotation that may remain projected on the patient 106 even when other 3D data has been hidden, for example, to assist in keeping track of a location of interest during surgery), or when the user 104 is using a measuring tool to make a measurement of the view of the patient 106 and/or to measure the projected 3D data.

[0074] In some embodiments, the method 600 may accomplish automatic alignment between 3D data of a patient and the actual patient. Further, this automatic alignment may be accomplished without manual alignment and/or without manual placement of non-anatomical fiducials, thus achieving automatic alignment more easily and more accurately than conventional forms of manual alignment.

[0075] Although the blocks of the method 600 are illustrated in FIGS. 6A-6E as discrete blocks, various blocks may be divided into additional blocks, combined into fewer blocks, reordered, expanded, or eliminated, depending on the desired implementation. For example, in some embodiments, blocks 602-612 may be performed without performing any of blocks 614-642. Further, in some embodiments, only blocks 602 and 612 may be performed, without blocks 604-610, such as where the registration and alignment between the patient and the 3D data is performed manually instead of automatically, in connection with any of blocks 614-616, 618-624, 626, or 628-642. Further, in some embodiments, blocks 628-632 may be performed without blocks 634-642. Also, in some embodiments, blocks 628-636 may be performed without blocks 638-642, blocks 628-632 and 638 may be performed without blocks 634-636 and 640-642, or blocks 628-632 and 640-642 may be performed without block 634-638. Further, in some embodiments, any of the blocks 614-642 may be performed in parallel.

[0076] In another example, the method 600 may further include dealing with the problem of automatic registration either before or after a patient is covered in surgical draping. For example, block 610 may be performed prior to covering a patient in surgical draping, and then the 3D data may be projected at block 612 onto the surgical draping. However, if block 610 is performed after a patient is covered in surgical draping, the method 600 may be modified to deal with the problem of the surgical draping obscuring a suitable outer layer of the patient. One such modification to the method 600 may include employing surgical draping that is sufficiently transparent that the AR headset can penetrate the surgical draping and find a more suitable outer layer of the patient. Another such modification may include placing visual markers on the outer layer of the patient in positions (such as in a particular pattern) that will remain visible after surgical draping and that can be noted during block 612. Then, even when large portions of the patient are covered in relatively opaque surgical draping, as long as the visual markers are still visible, an automatic re-registration can be performed using the visual markers as reference points. Another such modification includes placing extra-visual markers on the outer layer or the patient, or possibly inside the patient, in positions (such as in a particular pattern) that will not remain visible after surgical draping but that can be noted during block 612, either because they are visible during block 612 or because they are sensed by a sensor during block 612. These extra-visual markers may be made of a material that can be detected underneath the surgical draping by sensors in the AR headset, even though the extra-visual makers are not visible to the AR headset. For example, a metal detector sensor may detect metallic extra-visual markers (such as metallic mesh markers or a metallic marker inserted under the skin or into a body cavity), an infrared sensor may detect infrared-detectible extra-visual markers, a magnetic detector sensor may detect magnetic-field-emitting extra-visual markers, or a radio frequency detector may detect radio-frequency-emitting

extra-visual markers. Then, even when large portions of the patient are covered in relatively opaque surgical draping, as long as the sensors in the AR headset are able to detect the positions of the extra-visual markers underneath the surgical draping, an automatic re-registration can be performed using the extra-visual markers as reference points.

[0077] Further, it is understood that the method 600 may improve the functioning of an AR system itself and may improve the field of AR. For example, the functioning of the AR headset 108 of FIG. 1 may itself be improved by the method 600 by automatically registering a virtual position of the outer layer of the patient 106 from the 3D data to align with the registered real-time position of the outer layer (e.g. skin 106a and clothing 107) of the patient 106 in the 3D space 102 using the virtual morphometric measurements and using the real-time morphometric measurements and, in some instances, without using any non-anatomical fiducial. This automatic registration may be performed more easily and more accurately than conventional AR systems which employ manual registration or registration using manual placement of non-anatomical fiducials.

[0078] As indicated above, the embodiments described herein may include the use of a special purpose or general purpose computer (e.g., the processor 502 of FIG. 5) including various computer hardware or software modules, as discussed in greater detail below. Further, as indicated above, embodiments described herein may be implemented using computer-readable media (e.g., the memory 504 or file system 506 of FIG. 5) for carrying or having computer-executable instructions or data structures stored thereon.

[0079] In some embodiments, the different components and modules described herein may be implemented as objects or processes that execute on a computing system (e.g., as separate threads). While some of the methods described herein are generally described as being implemented in

software (stored on and/or executed by general purpose hardware), specific hardware implementations or a combination of software and specific hardware implementations are also possible and contemplated.

[0080] In accordance with common practice, the various features illustrated in the drawings may not be drawn to scale. The illustrations presented in the present disclosure are not meant to be actual views of any particular apparatus (e.g., device, system, etc.) or method, but are merely example representations that are employed to describe various embodiments of the disclosure. Accordingly, the dimensions of the various features may be arbitrarily expanded or reduced for clarity. In addition, some of the drawings may be simplified for clarity. Thus, the drawings may not depict all of the components of a given apparatus (e.g., device) or all operations of a particular method.

[0081] Terms used herein and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as “open” terms (e.g., the term “including” should be interpreted as “including, but not limited to,” the term “having” should be interpreted as “having at least,” the term “includes” should be interpreted as “includes, but is not limited to,” etc.).

[0082] Additionally, if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases “at least one” and “one or more” to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles “a” or “an” limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases “one or more” or “at least one” and indefinite articles

such as “a” or “an” (e.g., “a” and/or “an” should be interpreted to mean “at least one” or “one or more”); the same holds true for the use of definite articles used to introduce claim recitations.

[0083] In addition, even if a specific number of an introduced claim recitation is explicitly recited, it is understood that such recitation should be interpreted to mean at least the recited number (e.g., the bare recitation of “two recitations,” without other modifiers, means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to “at least one of A, B, and C, etc.” or “one or more of A, B, and C, etc.” is used, in general such a construction is intended to include A alone, B alone, C alone, A and B together, A and C together, B and C together, or A, B, and C together, etc. For example, the use of the term “and/or” is intended to be construed in this manner.

[0084] Further, any disjunctive word or phrase presenting two or more alternative terms, whether in the summary, detailed description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase “A or B” should be understood to include the possibilities of “A” or “B” or “A and B.”

[0085] Additionally, the use of the terms “first,” “second,” “third,” etc., are not necessarily used herein to connote a specific order or number of elements. Generally, the terms “first,” “second,” “third,” etc., are used to distinguish between different elements as generic identifiers. Absence a showing that the terms “first,” “second,” “third,” etc., connote a specific order, these terms should not be understood to connote a specific order. Furthermore, absence a showing that the terms first,” “second,” “third,” etc., connote a specific number of elements, these terms should not be understood to connote a specific number of elements. For example, a first widget may be described as having a first side and a second widget may be described as having a second side.

The use of the term “second side” with respect to the second widget may be to distinguish such side of the second widget from the “first side” of the first widget and not to connote that the second widget has two sides.

[0086] The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention as claimed to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described to explain practical applications, to thereby enable others skilled in the art to utilize the invention as claimed and various embodiments with various modifications as may be suited to the particular use contemplated.

CLAIMS

1. A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

determining virtual morphometric measurements of the outer layer of the patient from the 3D data;

registering a real-time position of the outer layer of the patient in a 3D space;

determining real-time morphometric measurements of the outer layer of the patient;

automatically registering a virtual position of the outer layer of the patient from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space using the virtual morphometric measurements and using the real-time morphometric measurements; and

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient.

2. The method of claim 1, where:

the registering of the real-time position and the determining of the real-time morphometric measurements are accomplished using sensors included in the AR headset; and

the sensors include one or more of infrared sensors, sound sensors, photographic sensors, fluoroscopy sensors, accelerometers, gyroscopes, and magnetometers.

3. The method of claim 1, wherein:
the 3D data of the patient is captured in real-time; and
the 3D data of the patient includes video.
4. The method of claim 1, wherein the outer layer of the patient is a skin layer of the patient.
5. The method of claim 1, further comprising:
prior to the registering of the real-time position, positioning the patient in a different position as the patient was in when the 3D data of the patient was captured; and
deforming the 3D data to match the different position of the patient.
6. The method of claim 1, wherein the 3D data includes one or more of MRI images, Computerized Tomography (CT) scan images, X-ray images, Positron Emission Tomography (PET) images, ultrasound images, fluorescence images, Infrared Thermography (IRT) images, and Single-Photon Emission Computed Tomography (SPECT) scan image.
7. The method of claim 1, wherein:
the projected inner layer of the 3D data of the patient is colored using a color gradient that represents tissue properties and that is altered to be visible when projected onto the real-time views of the outer layer of the patient; and
the tissue properties include one or more of tissue hardness, relaxivity, echogenicity, enhancement amount, enhancement speed, density, radioactivity, and water content.

8. The method of claim 1, wherein:
- the method further comprises positioning extra-visual markers on the patient;
 - the automatic registering further include automatically registering the real-time positions of the extra-visual markers with respect to the registered real-time position of the outer layer of the patient in the 3D space;
 - the method further comprises covering at least a portion of the patient and the extra-visual markers with an opaque surgical draping;
 - the method further comprises sensing, using a sensor of the AR headset, the real-time positions of the extra-visual markers underneath the opaque surgical draping; and
 - the method further comprises automatically re-registering a virtual position of the outer layer of the patient from the 3D data to align with the sensed real-time positions of the extra-visual markers.
9. The method of claim 1, wherein the automatic registering is performed using point set registration.
10. The method of claim 1, further comprising:
- generating a confidence score that the automatic registering is correct; and
 - presenting the confidence score to a user.
11. One or more non-transitory computer-readable media storing one or more programs that are configured, when executed, to cause one or more processors to perform the method as recited in claim 1.

12. A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

registering a virtual position of the outer layer of the patient from the 3D data to align with a real-time position of the outer layer of the patient in a 3D space;

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient;

determining real-time morphometric measurements of an object prior to insertion of the object into the patient through the outer layer of the patient;

automatically tracking a real-time position of the object in the 3D space with respect to the registered real-time position of the outer layer of the patient in the 3D space and with respect to the registered virtual position of the outer layer of the patient from the 3D data; and

while a portion of the object is inserted into the patient through the outer layer of the patient, displaying, in the AR headset, a virtual portion of the object projected into the projected inner layer of the patient from the 3D data.

13. One or more non-transitory computer-readable media storing one or more programs that are configured, when executed, to cause one or more processors to perform the method as recited in claim 12.

14. A method for augmenting real-time views of a patient with three-dimensional (3D) data, the method comprising:

identifying 3D data for a patient, the 3D data including an outer layer of the patient and multiple inner layers of the patient;

displaying, in an augmented reality (AR) headset, one of the inner layers of the patient from the 3D data projected onto real-time views of the outer layer of the patient;

generating, in the AR headset, a virtual user interface that includes options for altering the display of the projected inner layer of the patient from the 3D data;

displaying, in the AR headset, the virtual user interface projected onto real-time views while a focal orientation of the AR headset is not focused on the patient; and

hiding, in the AR headset, the virtual user interface while the focal orientation of the AR headset is focused on the patient.

15. The method of claim 14, further comprising:

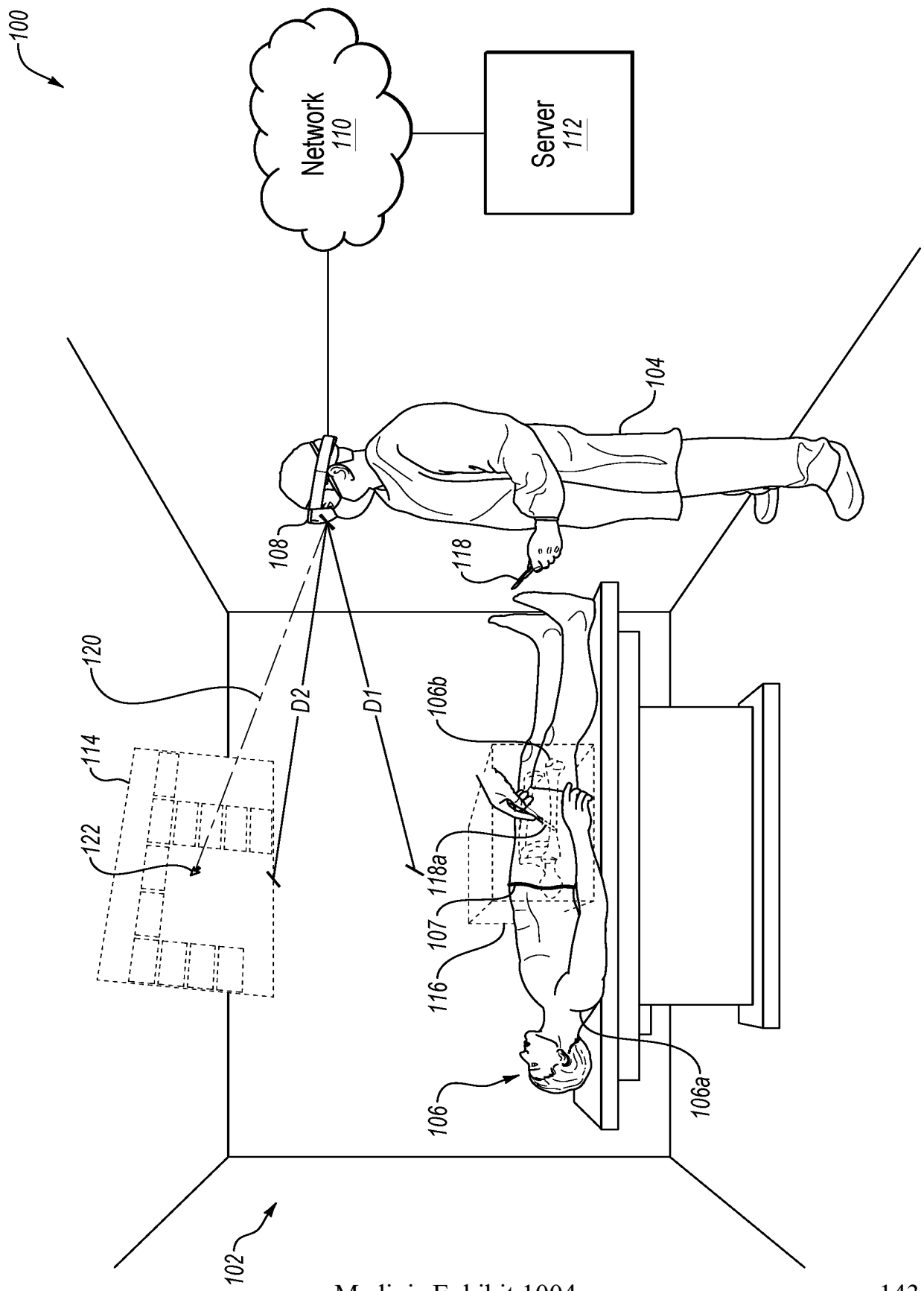
displaying, in the AR headset, a virtual cursor projected onto real-time views and/or onto the virtual user interface while a focal orientation of the AR headset is not focused on the patient; and

hiding, in the AR headset, the virtual cursor while a focal orientation of the AR headset is focused on the patient.

16. The method of claim 14, further comprising:
- determining a real-time distance of the patient from the AR headset; and
- updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually positioned at a focal distance from the AR headset that is about equal to the real-time distance of the patient from the AR headset.
17. The method of claim 14, further comprising:
- updating, in real-time, the displaying of the virtual user interface, in the AR headset, to cause the virtual user interface to be continually oriented perpendicularly to the focal orientation of the AR headset.
18. The method of claim 14, further comprising:
- displaying, in the AR headset, a virtual spatial difference box projected onto real-time views of the patient, the virtual spatial difference box confining within a volume of the virtual spatial difference box the projected inner layer of the patient from the 3D data.
19. The method of claim 18, wherein the virtual spatial difference box is configured to selectively display two-dimensional (2D) slices and/or 3D slices of the projected inner layer of the patient from the 3D data.
20. One or more non-transitory computer-readable media storing one or more programs that are configured, when executed, to cause one or more processors to perform the method as recited in claim 14.

ABSTRACT

Augmenting real-time views of a patient with three-dimensional (3D) data. In one embodiment, a method may include identifying 3D data for a patient with the 3D data including an outer layer and multiple inner layers, determining virtual morphometric measurements of the outer layer from the 3D data, registering a real-time position of the outer layer of the patient in a 3D space, determining real-time morphometric measurements of the outer layer of the patient, automatically registering the position of the outer layer from the 3D data to align with the registered real-time position of the outer layer of the patient in the 3D space using the virtual morphometric measurements and using the real-time morphometric measurements, and displaying, in an augmented reality (AR) headset, one of the inner layers from the 3D data projected onto real-time views of the outer layer of the patient.



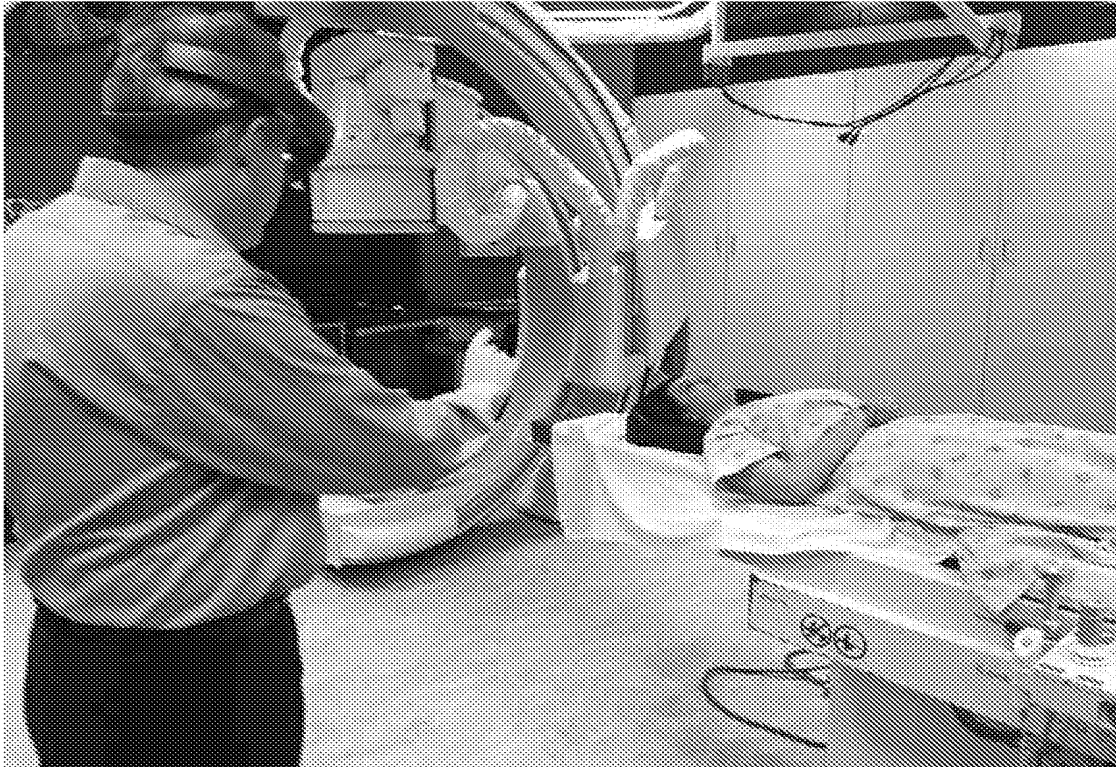


FIG. 2A

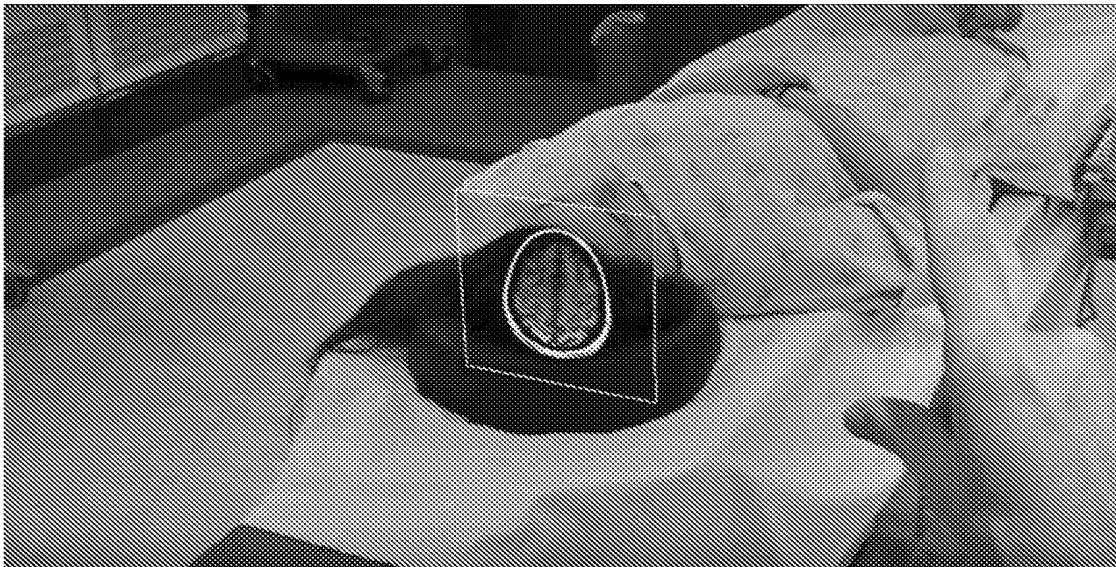


FIG. 2B

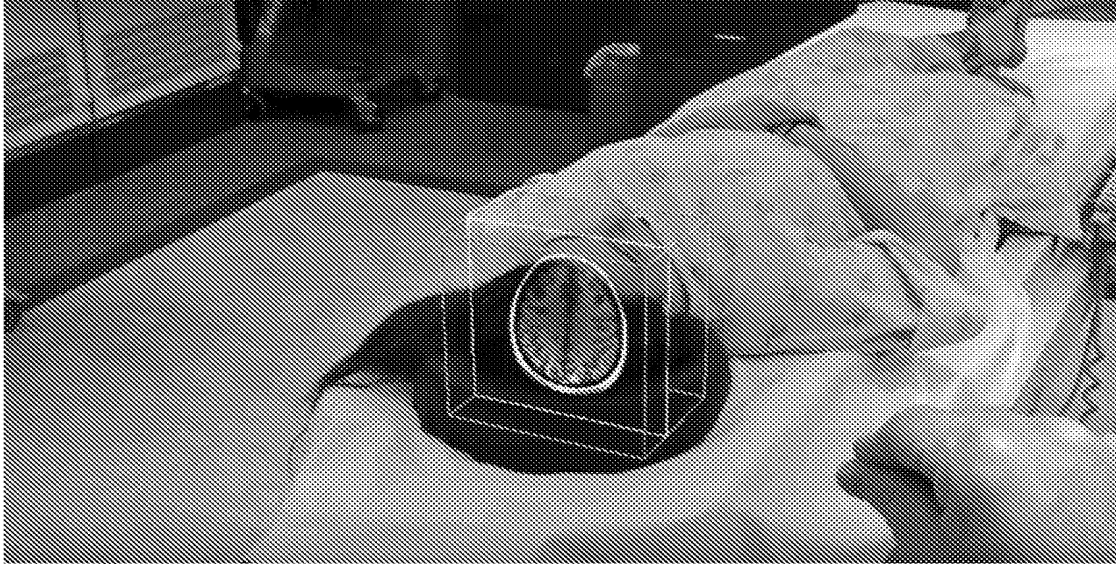


FIG. 2C

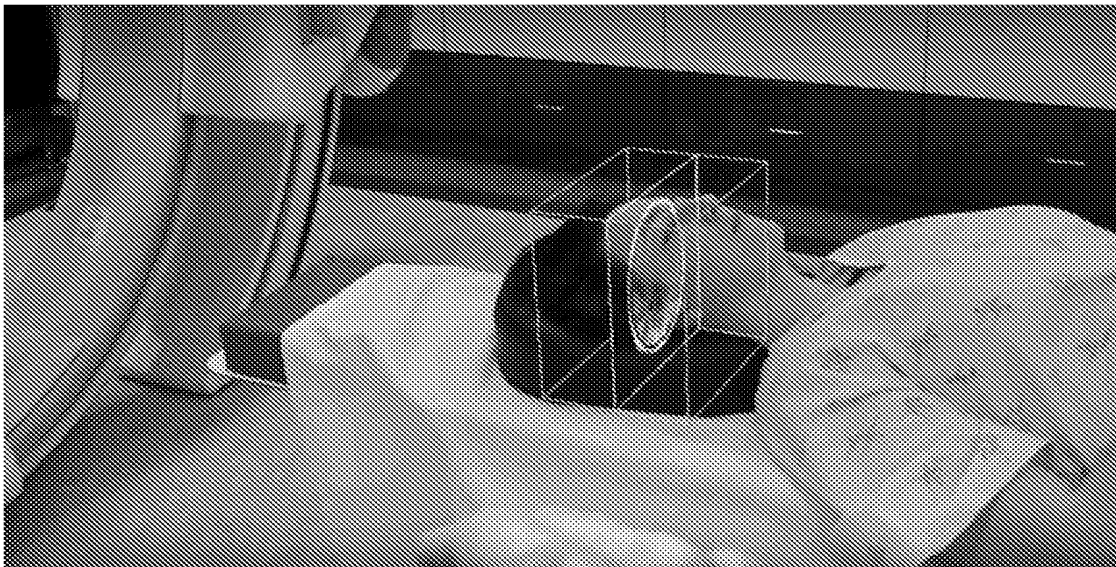


FIG. 2D



FIG. 2E



FIG. 2F

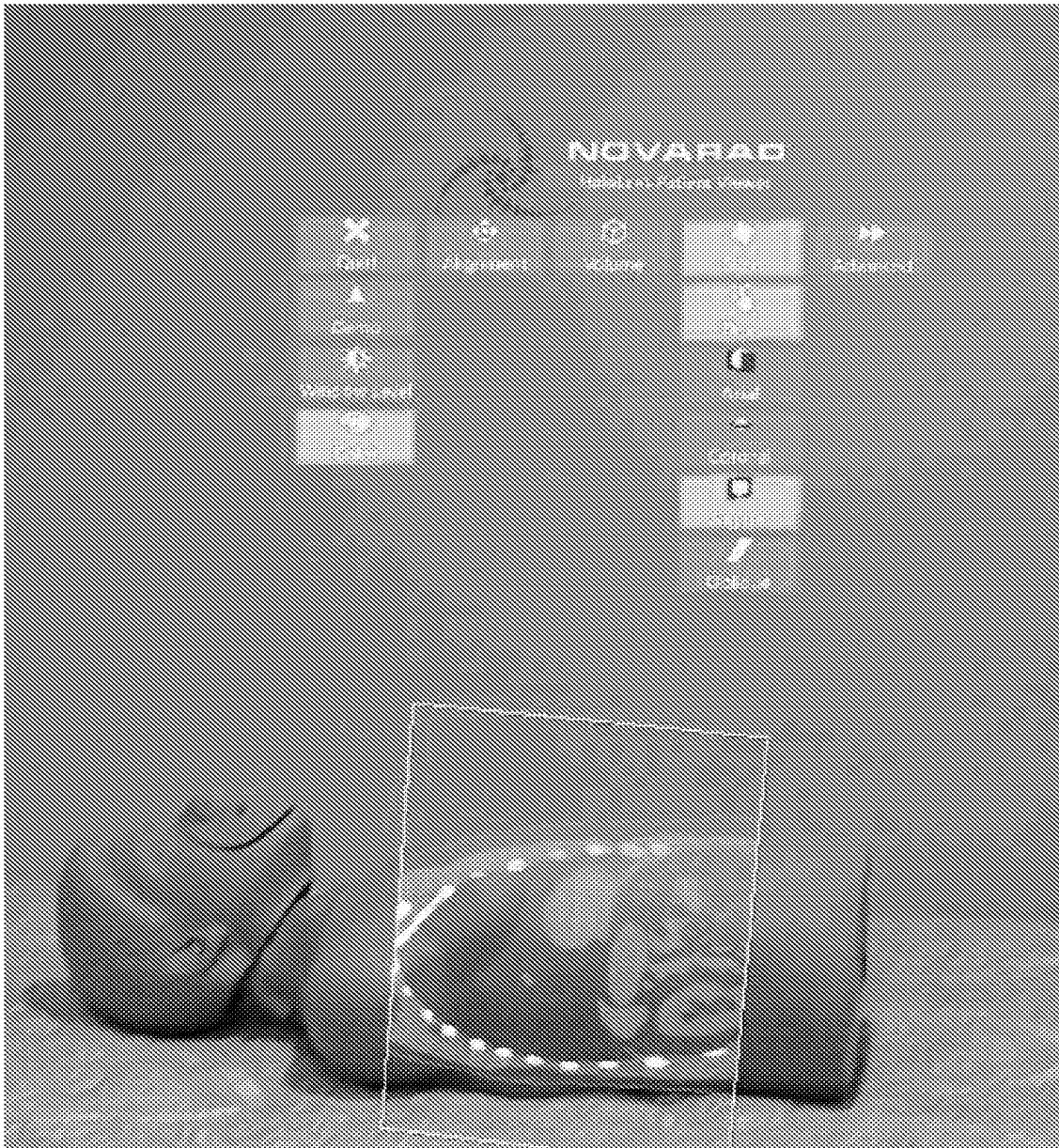


FIG. 3



FIG. 4A



FIG. 4B

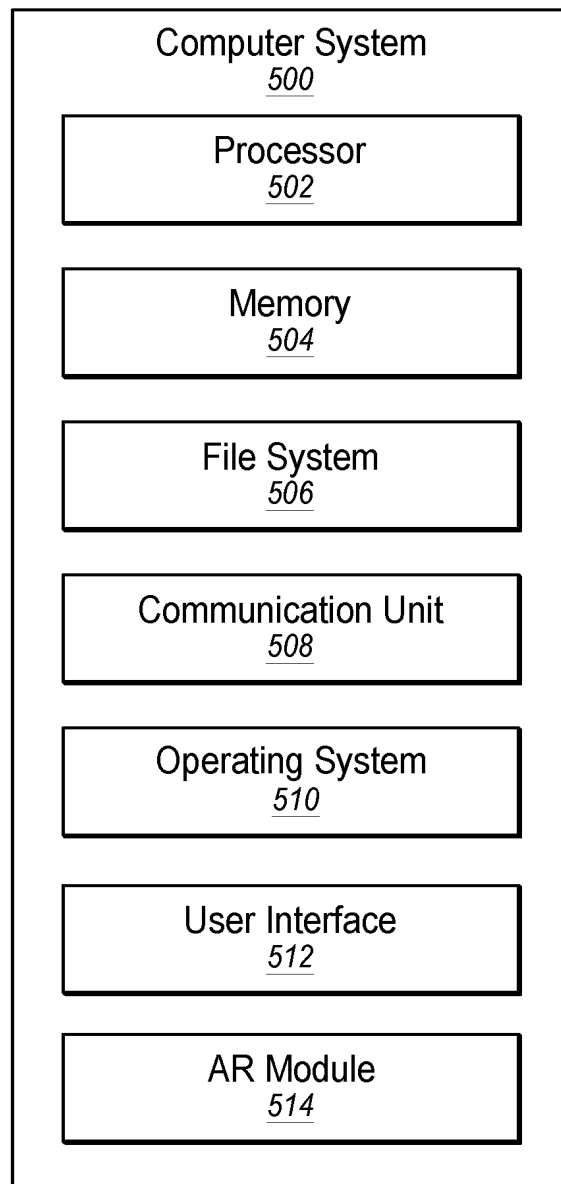
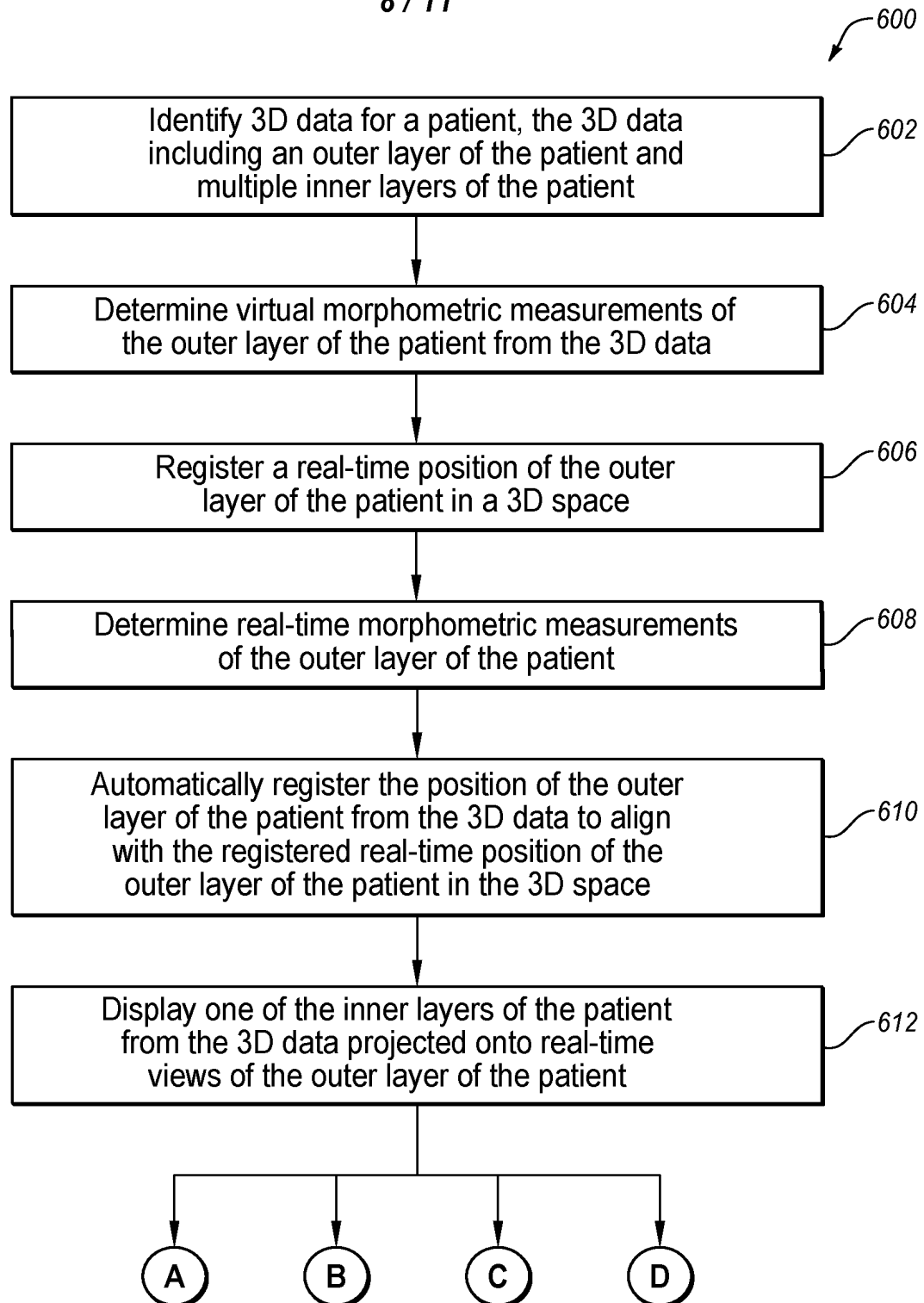


FIG. 5

**FIG. 6A**

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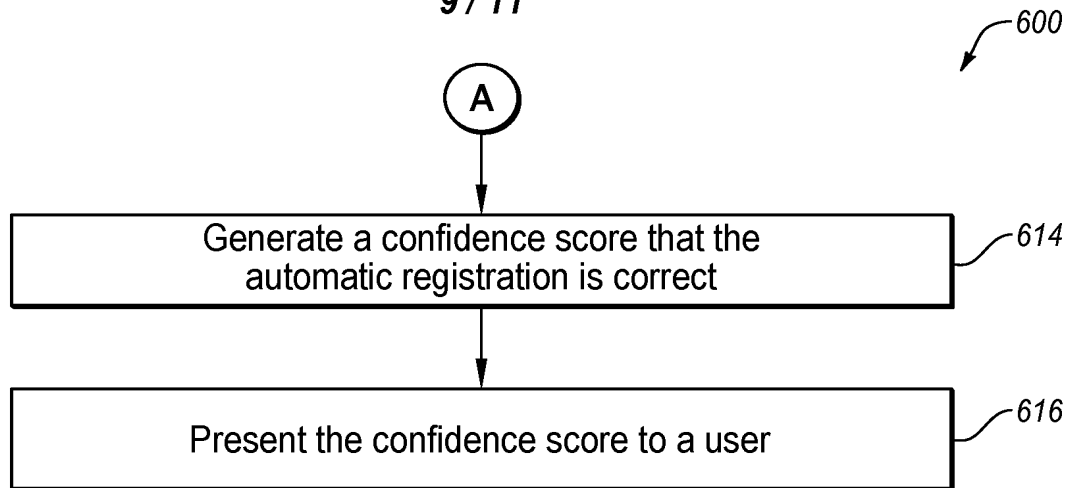


FIG. 6B

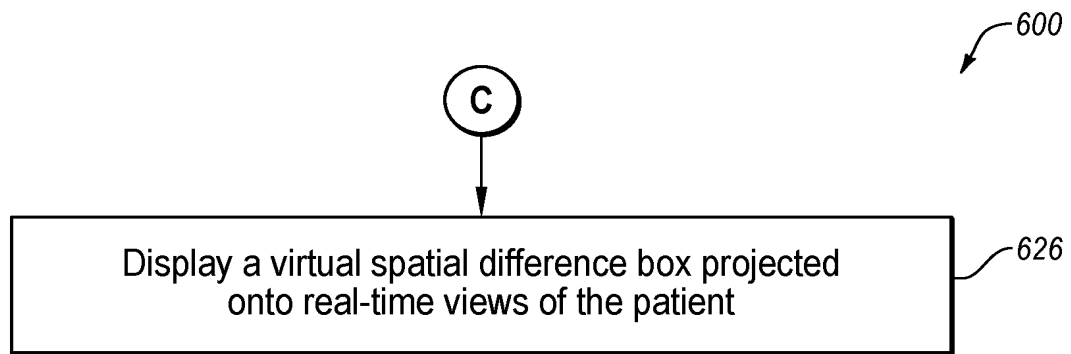
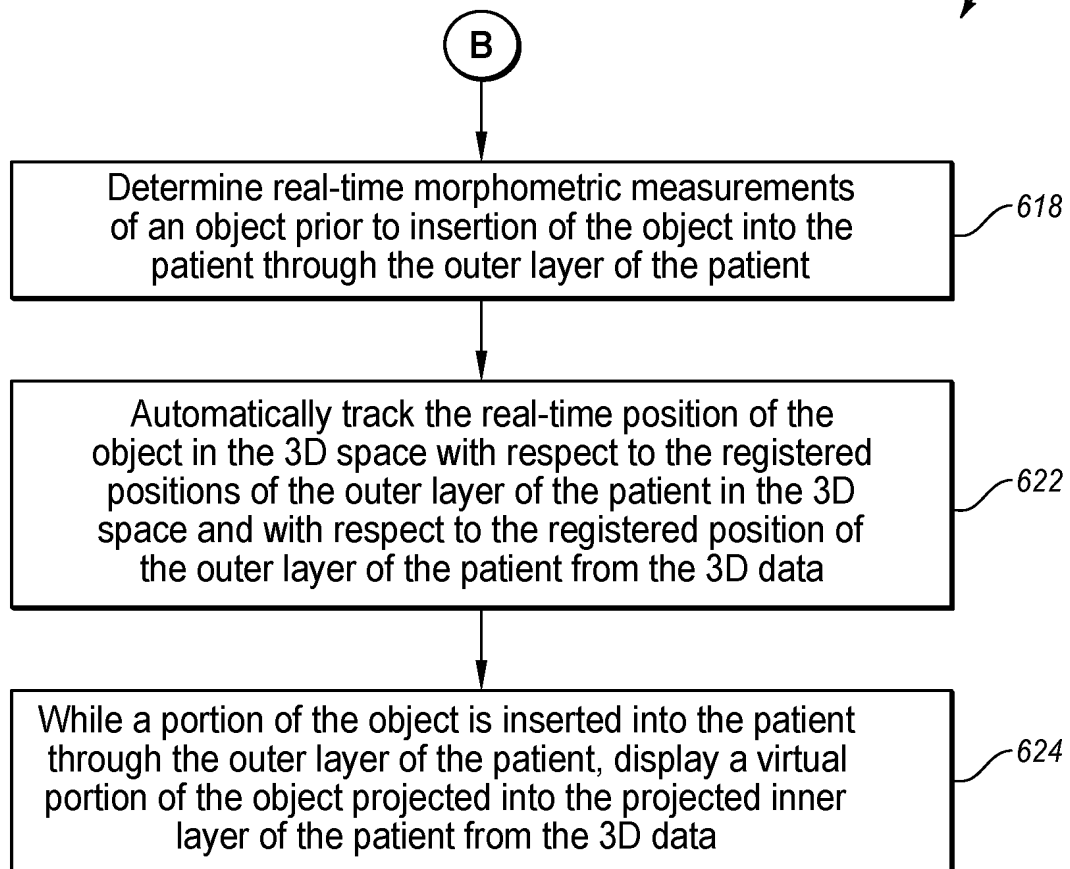


FIG. 6C

**FIG. 6D**

